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ABSTRACT

The International Environmental Education Program (IEEP) of UNESCO has developed a series of experimental teacher training modules in environmental education. This module focuses on the pre-service training of secondary social science teachers and supervisors in environmental education. Chapter 1 introduces the module and presents specific objectives of pre-service secondary school teacher training programs in environmental education. Chapter 2 deals with the history and philosophy of environmental education (and includes a description of the IEEP). Basic information about the biophysical and sociocultural aspects of the environment is presented in chapter 3, along with considerations about environmental ethics and environmental decision making. Chapter four discusses some environmental problems and possible solutions. Several teaching methodologies are described in chapter 5, with emphasis on problem solving strategies. Activities and experiments for teaching the environmental dimension in social science subjects are presented in chapter 6. Evaluation of environmental education instruction is addressed in chapter 7, and chapter 8 outlines strategies for planning, developing, and implementing an environmental education program. A bibliography is included. (TW)

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Unesco-UNEP International Environmental Education Programme

Environmental Educational Series **9**

Environmental Education: Module for Pre-Service Training of Social Science Teachers and Supervisors for Secondary Schools

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Division of Science, Technical and Environmental Education

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PREFACE

A series of experimental modules for the pre-service and in-service training of primary-school teachers, secondary-school science and social science teachers in environmental education has been prepared in the context of the Unesco-UNEP International Environmental Education Programme (IEEP) as a follow-up to the Tbilisi Conference Recommendations with respect to the training of teachers in environmental education.

This module focuses on the pre-service training of social science teachers and supervisors in environmental education for secondary schools. In this context the social science teachers are those concerned with the teaching of history, geography, social studies, economics, the arts, ethics and religion. The main objectives of the module are to: (a) foster the acquisition and transfer of knowledge, skills and affective attributes concerning the environment and its problems; and (b) develop competence in the teaching and supervision of the environmental dimension of social science in secondary schools. In this context, the module treats (a) historical and philosophical development of environmental education; (b) essential knowledge about the environment and its problems; (c) teaching methodologies, activities and experiments and evaluation in environmental education; and (d) strategies for the planning, development, implementation, management and evaluation of the environmental dimension of secondary school social science.

The Module for Pre-Service Training of Social Science Teachers and Supervisors in Environmental Education for Secondary Schools was prepared under Unesco contract at the National Council of Educational Research and Training, New Delhi, India, by Savita Sinha, N.K. Jangira and Supta Das. Professor Willard J. Jacobson, Teachers College, Columbia University, New York, U.S.A., edited the final version.

The Unesco-UNEP International Environmental Education Programme welcomes comments, for improving this module in its future versions, to be sent to the following address:

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INTRODUCTION

Environment is more than physical surroundings. It also includes the social environment. People do create as well as get moulded by the environment. Throughout history, mankind's most significant achievements have been gained from his struggle to adjust to his environment and modify it for his well-being. In this process, man has progressed no doubt but at the cost of social, biotic and physical environments because the self-healing character of nature is not infinitely tolerant.

In our present-day civilization, we have witnessed environmental problems arising out of over population, depletion of natural resources, food shortages, sprawling cities and metropolises and the resultant pollution. Solutions to the crisis facing us today can be appreciated and understood only by obtaining a basic background in some of the scientific concepts, which are essential for social science teachers and supervisors.

This module, therefore, sets out to help social science teachers and supervisors make social science teaching more environment-based and environment-oriented. Contents of the module interweave environmental issues and problems with principles of physical and life sciences necessary to their understanding. Besides, it explores a number of ways in which social science teachers can infuse environmental concepts in their lessons to improve environmental awareness.

Although environmental education can permeate all subject areas of the curriculum, social science teachers have slightly more responsibility since solutions to many environmental problems will depend upon complex economic, social and political considerations.

By presenting environmental concepts together with topics of social sciences as well as various teaching methodologies, suggested activities, experiments and evaluation techniques, it is hoped that the module will be readily teachable and it will also generate interest among students for the environment.

I express my deep sense of gratitude to Professor B.S. Parakh, Head, Department of Education in Social Sciences and Humanities and Dean, Academic, NCERT, for his inspiration and constant support throughout the project work. Grateful acknowledgements are due to the contributions of other members of the project team, Dr N.K. Jangira, Reader, Department of Teacher Education, Special Education and Extension Services, who has written chapters on 'Teaching methodologies' and 'Evaluation', and Mrs Supta Das, Research Associate, Department of Education in Social Sciences and Humanities, who has helped enormously especially in preparing chapters on 'Essential knowledge about the environment', 'Essential knowledge about the problems of the environment' and 'Suggested activities and experiments'. I am also indebted to Dr A.L.N. Sarma, Reader, DESSH, for reading some chapters of the module and providing his valuable suggestions. I am thankful to Miss Malabika Mukherjee, Junior Research Fellow in Geography, for her assistance in the project. Thanks are also due to all those academic and administrative staff of NCERT, who have helped at various levels, in completing the project.

New Delhi

Savita Sinha
Project Co-ordinator

CHAPTER 1

SCOPE AND OBJECTIVES

1.1 The scope

This module provides the contents of an experimental teacher-training course in environmental education (EE) for the pre-service training of secondary-school social science teachers and supervisors. While preparing the module, specific objectives of environmental education for pre-service training of teachers and supervisors have been kept in view. It is hoped that the module will help in preparing teachers to effectively achieve the goals of environmental education in their classrooms.

It has been assumed that the minimum qualification for secondary school social science teachers and supervisors, who will be joining the pre-service training programmes, would be graduation in any of the social science subjects. Therefore, they may not have sufficient background in science, especially ecology. An effort has, therefore, been made to clarify certain fundamental scientific concepts, which would help in knowing the environment in its totality. The resource materials of the module have been chosen carefully so that they have a wide adaptability across countries and eduational systems.

The content of the module has been organized in ten chapters. Chapter 1 introduces the module and presents specific objectives of pre-service secondary-school teacher training programmes in environmental education.

Chapter 2 deals with the history and philosophy of environmental education. Students of the training programmes have been introduced to the nature of this distinctive and purposive type of education and its origin as a response to the urgent environmental problems confronting mankind. Besides, goals, objectives and guiding principles of environmental education along with competencies required for teachers to provide an environmental dimension effectively to their teaching of different social science subjects have also been discussed in this chapter.

Essential knowledge about the environment has been presented in Chapter 3. It provides an explanation to man-environment interrelationships covering different aspects of natural and socio-cultural environments. An attempt has been made to explain all these environmental concepts which may be new to social science teachers but fundamental in understanding the natural and man-made components of the environment.

Chapter 4 discusses the problems of the environment and means and ways to their solutions. Environmental problems may be grouped in different ways. All major classifications have been presented briefly giving examples of environmental problems under each category. However, while discussing the first set of classifications, the nature of environmental problems has been discussed at length. As regards solution of the environmental problems, selection of the appropriate solution would depend upon several factors such as social, economic, political and technological conditions of the area in question. The best way, therefore, is to enable the students to follow right procedures, to investigate the problem and to choose an appropriate solution according to need and practicability.

Teaching methodologies have been discussed and explained in Chapter 5. Special emphasis has been laid on the problem-solving approach.

Experiments and activities to facilitate the learning and teaching about the environment have been suggested in Chapter 6. Evaluation in environmental education has been discussed in Chapter 8. Effective environmental education needs to be related to local and current situations since distant and exemplary situations can be included in the permanent curricular areas.

Pre-service teachers have also been introduced to strategies for planning, development, implementation, management and evaluation of secondary school social science curriculum in environmental education. However, equipping the teachers with essential concepts of environmental education and with the skills and strategies for its design and teaching may not be enough for the successful implementation of environmental education programmes in schools. All educational systems have several constraints that hinder innovations. It is necessary to identify and control such constraints. Sometimes, these constraints go beyond the control of the classroom teachers. In such situations social science supervisors have to play their key roles. They can create conditions in schools bringing innovations for curriculum and teaching. In fact, it is necessary to provide support for environmental education programmes at three levels, where the constraints are most obvious. They are school, education system and the community. Within the school the constraints are timetable difficulties, conflict with traditional teaching approaches, lack of resources and lack of co-operation from other staff members and administrators. Within the education system, constraints are in the form of overcrowded curriculum, unsupportive examination system and financial difficulties. Within the community, problems in getting support from parents and other community members and lack of outside resources, may be regarded as contraints. Social science teachers and supervisors should try to identify the major constraints and to find solutions for these problems.

Chapter 10 summarizes the main features of the module.

This module is a package for use by secondary-school social science teachers as a part of their pre-service training course, because environmental issues are rooted mostly in socio-cultural value conflicts. As such, the social science methods courses could easily provide environmental content by using issue-related topics.

1.2 Specific objectives of pre-service training of social science teachers and supervisors in environmental education

1. To increase environmental awareness, sensitivity and consciousness of pre-service (student) teachers and supervisors towards the environment, its problems and their solution and prevention.

2. To acquaint pre-service teachers and supervisors with the need, the importance, the goals, objectives and guiding principles of environmental education (see Recommendations No. 1 and 2, Tbilisi Final Report).

3. To acquaint pre-service teachers and supervisors with essential knowledge about the environment and its allied problems.

4. To acquaint pre-service teachers and supervisors with fundamental environmental concepts that may permeate social studies subjects.

5. To help pre-service teachers and supervisors realize the totality of the environment as a fundamental base for interdisciplinary relations among school subjects.

6. To familiarize pre-service teachers and supervisors with teaching methodologies such as problem-solving approaches in environmental education, especially with respect to the teaching of the environmental dimension of secondary school social science subjects.

7. To familiarize pre-service teachers and supervisors with certain activities and experiments essential to and motivating for the learning and teaching of the environmental dimension of secondary-school social science subjects.

8. To familiarize pre-service teachers and supervisors with the development of lesson plans and the preparation of teaching materials in the form of units or modules, etc. on the environmental dimension of secondary-school social science subjects.

9. To familiarize pre-service teachers and supervisors with evaluation techniques and methodologies in environmental education for understanding the progress of secondary-school students, as well as the teacher's own teaching effectiveness with regard to the fundamental dimension of secondary-school subjects in fulfilment of environmental education objective.

10. As environmental education is becoming a common denominator for almost all educational renewal, it would seem essential to orient pre-service teachers and supervisors towards strategies for planning, development, implementation, management and evaluation of curricula in environmental education.

CHAPTER 2

NEED AND BASIS OF ENVIRONMENTAL EDUCATION FOR PRE-SERVICE TRAINING OF SECONDARY-SCHOOL SOCIAL SCIENCE TEACHERS AND SUPERVISORS

2.1 What is environmental education?

Environmental education has been defined in a number of ways. However, since the early 1970s, they have all tended to emphasize similar points to those in the Nevada Conference of the International Union for the Conservation of Nature and National Resources in 1970.

> Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture and his biophysical surroundings. Environmental education also entails practice in decision-making and self-formulating of a code of behaviour about issues concerning environmental quality.

In the seminar on environmental education organized by the Finnish National Commission for Unesco at Jammi in 1974, it was defined as '... a way of implementing the goal of environmental protection. Environmental education is not a separate branch of science or subject of study. It should be carried out according to the principle of lifelong integral education'.

Proceedings of the Organization of American States Conference on Education and Environment in the Americas, 1971, stated:

> Environmental education involves teaching about value judgements and the ability to think clearly about complex problems - about the environment - which are as political, economical, and philosophical as they are technical.

In the United States Public Law 91-516 the Environmental Education Act states environmental education as:

> The educational process dealing with man's relationship with his natural and man-made surroundings, and including the relation of population, pollution, resources allocation and depletion, conservation, transportation, technology and urban and rural planning to the total human environment.

In summary environmental education is an action process related to the work of almost all subject areas. It is concerned with the dynamic relationships between man and nature. It aims at improving the environmental quality.

2.2 History and philosophy of environmental education

Man has been an inseparable part of the environment ever since his appearance on the earth, which was itself an outcome of environmental processes. In the beginning, limited needs of primitive men did not disturb the harmony of nature since the amount and quality of damages to the environment were insigificant. But in later years, growth of human population and its various needs as well as scientific and technological advancements, accelerated and the pace of environmental degradation. Diminishing forests, loss of fertile soil due to salinization, soil erosion and urbanization, industrialization, depletion of mineral and power resources, extinction of several living species, and growing pollution are some of the

examples which have led to present-day environmental crises. This only suggests that man has a careless attitude towards the environment. Environmental degradation if not checked in time, will endanger the existence of the human being itself.

Need of the hour is to have environmentally conscious citizens, who are concerned for saving the environment from disasters. It might happen only when people are knowledgeable about their environment and associated problems; are aware of the solutions to these problems and are motivated to work for that. This naturally means change in the attitude and behaviour of the public.

Education has always played a crucial role in the society because it disseminates knowledge, provides necessary skills and helps in forming certain attitudes. Hence, the Stockholm Conference on Human Environment in 1972 emphasized the need for an environmentally oriented education system which would resolve the environmental crisis by preparing environmentally conscious citizens.

Hence, environmental education is not a new discipline but a new dimension in the education system. However, this concept emerged only in the 1970s. Earlier, environment formed part of formal and non-formal education no doubt but it was never treated as a whole. Different aspects of environment constituted parts of different disciplines e.g. biology, geography, economics and others and thus were dealt with in isolation. Gradually, man's intervention in the environment increased. This caused concern among some people who realized the changes therein. A new movement concerning conservation of resources and ecological studies initiated some deep-rooted thinking on man-environment interrelationships. Environmental degradation in terms of undesirable impacts of technology and economic activity became a matter of international concern by the end of the 1960s. Developed countries had already started experiencing the results of human exploitation of the environment. Developing countries were interested in making best possible use of the environment for their developmental activities.

The Stockholm Conference

Worldwide growing concern regarding the need to do something about the conservation and improvement of the environment for mankind, prompted the United Nations to convene a conference on human environment in Stockholm between 5 to 16 June 1972. It attracted a large number of participants. Besides the Secretary-General of the United Nations and representatives from Specialized Agencies of the United Nations and other interested organizations, representatives from 113 countries attended this conference. For the first time, countries of the world assembled together to work out a practical plan of action for the benefit of all mankind. The need for a common outlook towards environmental improvement and concerted efforts by all governments and peoples of the world to achieve the goal was stressed. The deliberations of the conference resulted in the Declaration of the United Nations Conference on the Human Environment. It emphasized that the conservation and improvement of the environment for present and future generations was the main goal of the conference. To meet this goal, 12 principles were formulated and new strategies were framed to be incorporated in developmental activities.

Experiences of the developed world helped developing nations in finding a new synthesis between environment and development. The nature of environmental problems is totally different from the developed to the developing world. As such, in any developmental strategy, all environmental factors, including the socio-economic aspects, must form an integral part. Environmental programmes and activities should be designed and implemented with due care.

The conference made 109 recommendations in all, which may broadly be grouped under five important themes:

(a) environmental aspects of natural resources management;

(b) planning and management of human settlements for environmental improvement;

(c) identification of major pollutants and their control;

(d) educational, socio-cultural and informational aspects of environmental issues; and

(e) environment and development.

While formulating the action plan, all the recommendations of the conference were categorized under three sections - environmental assessment, environmental management and supporting measurements e.g. education and training programmes, financial and technical assistance.

As per the decision of the conference, the United Nations Environment Programme Headquarters was established in Nairobi. It was structured on the pattern worked out by the conference. An environment fund was started to assist the financing of environmental projects to which member countries contributed voluntarily.

The Stockholm Conference also initiated the idea of observing World Environment Day on 5 June every year. This was meant for creating an awareness among people through organization of various activities concerning the environment.

As stated earlier, even the concept of environmental education emerged from this conference. United Nations agencies were requested to organize 'formal' and 'mass' environmental education programmes at the global level. Recommendations 95-101 of the conference emphasized the need for environmental education since it was realized that it would help every individual to acquire the essential knowledge and skills and would develop proper attitudes and commitment to improve the environmental quality. The United Nations Conference on the Human Environment thus provided an impetus for promoting interest in environmental education during the 1970s.

2.3 The Unesco-UNEP International Environmental Education Programme (IEEP)

In response to Recommendation 96 of the Stockholm Conference, Unesco and UNEP launched an International Environmental Education Programme (IEEP) in 1975 which aimed at promoting exchange of information and experiences, research and experimentation, training of personnel, curricula and materials development, and international co-operation in the field of environmental education. As a part of the activities of IEEP, an international workshop on environmental education was held at Belgrade in 1975. The Belgrade Charter proposed a number of guiding principles of environmental education programmes. The Charter also stressed that environmental education should:

be a continuous lifelong process;

be interdisciplinary in approach;

consider the environment in its totality;

emphasize active participation in preventing and solving environmental problems;

examine major environmental issues from a world point of view giving due importance to regional differences; and

promote the value of local, national and international co-operation in the solution of environmental problems (Holdgate, et al., 1982).

The IEEP followed up this workshop by several expert meetings on environmental education in Africa (Brazzaville, 1976), Arab countries (Kuwait, 1976), Asia (Bangkok, 1976), Europe (Helsinki, 1976), Latin America (Bogota, 1976) and North America (Saint Louis, 1976).

The Intergovernmental Conference on Environmental Education

Two years after the 'Belgrade Workshop' the first Intergovernmental Conference on Environmental Education organized by Unesco in co-operation with UNEP was held at Tbilisi, Union of Soviet Socialist Republics, in 1977. It brought together representatives from government as well as non-government agencies and organizations to discuss and recommend appropriate measures to promote environmental education at all levels. The Tbilisi Conference emphasized the importance of environmental education in the preservation and improvement of the world's environment. Urgent need was felt to properly plan and manage human activities to check the accelerated rate of environmental degradation. For clarifying the role of education and measures to be adopted, the participants were given a common understanding of the nature and causes of environmental problems.

Environmental problems exist in all countries and at all stages of development, but they vary in nature, magnitude and complexity. Environmental problems of developing countries are mostly related to improper modes of development and underdevelopment e.g. poverty, hunger, malnutrition and diseases. In developed countries, on the other hand, environmental problems rise due to fast development which results in depletion of resources, wastage of resources and pollution.

The Tbilisi Conference reinforced the major goals of environmental education which were to develop awareness and concern among the world population about the ecological, economic, political and social interaction and interdependence in the environment and their problems. Opportunities were to be provided to the people to acquire the knowledge and skills and to develop proper values and attitudes towards the environment. The objectives of environmental education, as established by the conference, were to develop the following qualities in individuals and social groups:

(a) an awareness of the environment and its problems;

(b) basic knowledge and understanding of the environment and its interrelationship with man;

(c) social values and attitudes which are in harmony with the environmental quality;

(d) skills to solve environmental problems;

(e) ability to evaluate environmental measures and education programmes;

(f) a sense of responsibility and urgency towards the environment so as to ensure appropriate actions to solve environmental problems.

To meet these objectives, a number of guiding principles were framed for environmental education curriculum developers. These were related to the design and structure of educational content, educational strategies and learning procedures. It was emphasized once again that environmental education should be a forward-looking and a continuous lifelong process; consider the environment in its totality; follow a problem-solving interdisciplinary approach; and adopt a world outlook with due regard to regional differences. In acquisition and transfer of learning, practical activities and first-hand experience were to be given due stress.

It was clearly stated that environmental education was not a new discipline but a new dimension in the existing curricula cutting across different disciplines. It should, therefore, form an essential component of all programmes and courses of the existing education system. In content, environmental education should include ecological concept and natural as well as socio-economic aspects of the environment.

The conference outlined strategies for the promotion of environmental education at the national level. The target groups for environmental education included public, professional and scientific groups such as engineers, agriculturalists, administrators, planners and teachers. Various professional groups required the essential knowledge about the environment in different ways. For example, needs of a planner were totally different from the needs of a soil-scientist because they dealt with altogether different aspects of environment.

The Tbilisi Conference emphasized the pre-service and in-service training of teachers in environmental education. It was further highlighted during the conference that pre-service and in-service training programmes for teachers and educational administrators would enable them to incorporate environmental dimensions effectively into their respective activities. It was necessary to prepare and develop teaching and learning materials which would form the basis of such training programmes. It was also stressed that training should help producing environmental integration skills in the use of interdisciplinary approach and methodology for achieving the objectives of environmental education effectively.

Besides teacher training programmes, dissemination of information through the mass media was also emphasized. For inculcating a sense of responsibility and a spirit of solidarity among nations, need was felt to increase international co-operation in environmental education.

Forty-one specific recommendations of the Tbilisi Conference provided a basic framework for planning, guiding and improving national efforts in environmental education at various levels. This conference was the culminating point of the first phase of the Unesco-UNEP International Environmental Education Programme which exemplifies the efforts being made to meet the objectives of environmental education. Under this programme, an environmental education newsletter 'Connect' is published quarterly in five languages. In addition, a computerized data base has been established which contains a wide variety of information related to environmental education. A number of pilot projects in different parts of the world are being provided financial and technical assistance under the Unesco-UNEP programme.

The decade after the first United Nations Conference on Human Environment in 1972 has witnessed several changes in the state of environmental education and public understanding. Courses were designed from primary levels to tertiary levels. Environmental issues being different in each country necessitated use of varied educational approaches.

Environmental awareness and public participation increased especially in rich nations where media played an important role. Public organizations affected the decision-making process in a number of countries (Holdgate, et al., 1982).

Goals and objectives

The overall goal of environmental education is to generate environmental action so as 'to improve all ecological relationships including the relationship of humanity with nature and people with one another' (Belgrade Charter, 1975).

The Tbilisi Conference elaborated the goals of environmental education as the following:

(a) to foster clear awareness of, and concern about economic, social, political and ecological interdependence in urban and rural areas;

(b) to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; and

(c) to create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

Environmental education objectives endorsed at Tbilisi are as follows:

(a) awareness: to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems;

(b) knowledge: to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems;

(c) attitude: to help social groups and individuals acquire a set of values and feelings of concern for the environment, and the motivation for actively participating in environmental improvement and protection;

(d) skills: to help social groups and individuals acquire the skills for identifying and solving environmental problems;

(e) participation: to provide social groups and individuals with an opportunity to be actively involved at all levels in working towards resolution of environmental problems.

Guiding principles

The Tbilisi Conference also stated the guiding principles of environmental education which are as the following:

Environmental education should:

consider the environment in its totality - natural and built, technological and social (economic political, technological, cultural - historical, moral, aesthetic);

be a continuous lifelong process, beginning at the pre-school level and continuing through all formal and non-formal stages;

be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;

examine major environmental issues from local, national, regional and international points of view so that students receive insights into environmental conditions in other geographical areas;

focus on current and potential environmental situations, while taking into account the historical perspective;

promote the value and necessity of local, national and international co-operation in the prevention and solution of environmental problems;

explicitly consider environmental aspects in plans for development and growth;

enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences;

relate environmental sensitivity, knowledge, problem-solving skills and values clarification to every age but with special emphasis on environmental sensitivity to the learner's own community in early years;

help learners discover the symptoms and real causes of environmental problems;

emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills;

utilize diverse learning environments and a broad array of educational approaches to teaching/learning about and from the environment with due stress on practical activities and first-hand experience.

To achieve the goals and objectives of environmental education, it was seen that environmental education needs to be planned nationally.

In the formal school, environmental education concepts may be carefully integrated with different subject areas in a creative and functional manner. However, it requires careful planning and implementation strategies.

2.4 Environmental education and secondary schools

Students enter secondary schools between the ages of 11 and 14 and leave between ages 16-19. They thus belong to one of the most sensitive groups of population who may be initiated, involved and prepared for understanding and tackling the environmental problems to the extent possible. Secondary-school students are usually receptive and strongly motivated. They are also capable of assimilating an

environmental education that is: (i) value-oriented; (ii) community-oriented; and (iii) concerned with human well-being. Environmental education programmes for this age-group should, therefore, be geared to provide these dimensions.

Two approaches to environmental education have developed over the years (Holdgate, et al., 1982):

(a) to underline the environmental aspects of each element of the student's learning processes;

(b) to bring in environmental education as a synthesis of various elements of the secondary-school curricula through an integrative study of interrelations.

Although these approaches are similar to approaches in the primary school, experimental and field studies may be part of the secondary-school environmental education. Students should get involved in out-of-school activities, problem-solving and community activity related to environmental problems.

Environmental dimensions may be incorporated in the school curriculum in different ways. Environmental studies may be introduced as a special subject, which may be taught by specially trained teachers. But this may be overburdening the students with one additional subject and they may be averse to it from the beginning. Alternatively, the content of environment education may be broken into units. These may be merged with different subject areas like, biology, geography, history, etc. spreading over the whole secondary-school term. It would still be better if instead of units, the concepts were integrated into different subject areas. But incompetent teachers in both cases may make the teaching of these units on concepts just incidental without making environmental issues relevant to the students' life. For tackling this problem, a national advisory committee on environmental education may be constituted at the national level who would help in designing the proposed courses (Stapp, 1971). Teachers may be trained accordingly.

2.5 Pre-service training of secondary-school social science teachers and supervisors in environmental education

Irrespective of the ways the environmental education is introduced in the school curriculum, success of the programme would depend primarily on teachers, since they are the central figures in schools. Hence, they should be open-minded and receptive to new ideas, as also imaginative and capable of making teaching learning process more effective. During the past decade much has been written about the need for teacher training programmes in environmental education. Several Unesco publications have discussed this issue in great detail. It has been stated that 'the possibilities of integrating environmental education into formal and non-formal education programmes and the implementation of such programmes depend essentially (without however underestimating the importance of other factors) on the training of the personnel responsible for putting the programme into effect' (Unesco, 1977).

In this context, pre-service training of teachers is of paramount importance. Recommendation 17 of the Tbilisi Conference emphasizes the pre-service training of teachers and supervisors. Competent teachers do not emerge out of the blue. They must acquire and practice the attributes of competency and skills during their education. Teachers training colleges should, therefore, review their teacher training programmes in the light of the philosophy of environmental education.

A secondary-school social studies teacher would require more expertise than is required by a primary-level teacher. They are expected to acquire certain competencies some of which are unique applications of knowledge, attitude, behaviour and skills to environmental education, while the others are general education competencies pertinent to environmental education as well as to other disciplines (Unesco, 1980). It is impossible to achieve all competencies within a single education programme. But these may be developed gradually throughout the individual educator's career. Some of these competencies may be used to develop pre-service training courses.

Secondary-school social science teachers should be able to:

identify an environmental problem;

investigate a problem (identifying and acquiring the relevant background knowledge that is to be used by the class);

prepare and evaluate possible solutions to the problem;

identify possible strategies for social action;

evaluate the strategies for social action.

Social studies teachers should study the man-environment relationship at their own level of inquiry and explore the contribution which their subjects can make in the field of environmental education. Besides, it would be beneficial for them to have some idea of basic concepts in ecology since it would help them appreciate other interrelated concepts. A detailed list of competencies particularly with reference to environmental education content (Unesco, 1980) is being reproduced for the benefit of teachers.

Level I: Ecological foundations

The effective environmental education teacher should be able to:

apply a knowledge of ecological foundations to the analysis of environmental issues and identify key ecological principles involved;

apply a knowledge of ecological foundations to predict the ecological consequences of alternative solutions to environmental problems;

be sufficiently literate in ecology to identify, select and interpret appropriate sources of scientific information in a continuing effort to investigate, evaluate and find solutions for environmental problems;

communicate and apply in an educational context, the major concepts in ecology.

Level II: Conceptual awareness

The effective environmental education teacher should be able to select, develop and/or implement curricular materials which will effectively make receivers aware of:

how man's cultural activities (e.g. religious, economic, political, social, etc.) influence the environment from an ecoloical perspective;

how individual behaviours impact on the environment from an ecological perspective;

a wide variety of local, regional, national and international environmental issues and the ecological and cultural implications of these issues;

the viable alternative solutions available for remediating discrete environmental issues and the ecological and cultural implications of these alternative solutions;

the need for environmental issue investigation and evaluation as a prerequisite to sound decision-making;

the roles played by differing human values in environmental issues and the need for personal value clarification as an integral part of environmental decision-making;

the need for responsible citizenship action (e.g. persuasion, consumerism, legal action, political action, eco-management) in the remediation of environmental issues.

Level III: Investigation and evaluation

The effective environmental education teacher should be competent to investigate environmental issues and evaluate alternative solutions and to develop, select and/or implement curricular materials and strategies which will develop similar competencies in receivers, including:

the knowledge and skills needed to identify and investigate issues (using both primary and secondary sources of information and to synthesize the data gathered);

the ability to analyse environmental issues and the associated value perspectives with respect to their ecological and cultural implications;

the ability to identify alternative solutions for discrete issues and the value perspectives associated with these solutions;

the ability to autonomously evaluate alternative solutions and associated value perspectives for discrete environmental issues with respect to their cultural and ecological implications;

the ability to identify and clarify their own value positions related to discrete environmental issues and their associated solutions;

the ability to evaluate, clarify and change their own value positions in the light of new information.

Level IV: Environmental action skills

The effective environmental education teacher should be competent to take positive environmental action for the purpose of achieving and/or maintaining a dynamic equilibrium between quality of life and the quality of environment, and to develop, select and/or implement curricular materials and strategies to develop similar competencies in receivers to take individual or group action when appropriate (i.e. persuasion, consumerism, political action, legal, action, eco-management, or combinations of these action categories).

The teacher will find the new emphasis, approach and methodology required for this type of education radically different from the education that they have received in the past. Nevertheless, this would equip them to translate the objectives of environmental education more effectively.

Equipping the social science teachers with the concepts of environmental education and with the skills and strategies for its design and teaching is only one of the requirements for the implementation of environmental education in schools. All education systems have some constraints that hinder the innovation in any curriculum and teaching. Some of the constraints are quite beyond the control of the classroom teacher. In this context social studies supervisors have key roles. They can help reduce such constraints to make environmental education teaching/learning more effective.

The implementation of pre-service teacher training programmes in environmental education in general varies greatly from institution to institution and nation to nation. In some countries, pre-service training courses include courses in environmental education for teacher certification. This is encouraging. However, with a few exceptions, the training provided only in ecology or in conservation may not be adequate to develop all competencies needed to infuse the environmental dimension into the teaching of different social studies subjects. It is, therefore, essential that besides the ecological components, aspects of social enironment should also form an integral part of environmental education courses for pre-service training of social science teachers and supervisors. It is felt that ecological concepts are essential for basic knowledge about the environment no doubt, but it is incomplete without human aspects since values and attitudes are influenced by the socio-cultural environment on the one hand and guide decisions and actions of an individual and/or a society on the other.

CHAPTER 3

ESSENTIAL KNOWLEDGE ABOUT THE ENVIRONMENT FOR SECONDARY SCHOOL SOCIAL SCIENCE TEACHERS AND SUPERVISORS

This part of the module is prepared with a view to help social science teachers and supervisors acquire essential knowledge about the environment and its basic concepts. This would provide an environmental dimension to social science subjects making its teaching/learning more relevant.

3.1 Introduction

The environment must be viewed in its totality which comprises the whole set of natural or biophysical and man-made or socio-cultural systems in which man and other organisms live and interact. The natural environment consists of physical environment and biological environment. The physical environment is comprised of three interlocking systems: the atmosphere, the hydrosphere and the lithosphere. The biological environment includes all living organisms of the biosphere, which merges imperceptably into the lithosphere, the hydrosphere and the atmosphere (Odum, 1975). Plants, animals and micro-organisms living within a defined zone together with the physical factors (e.g. air, water and soil) of that area, form an ecosystem. Living organisms and their physical environment within an ecosystem have dynamic interrelationships. These relationships may be expressed as natural cycles which continuously circulate most of the essential constituents necessary for life. In the unpolluted natural environment, the cycles mainly operate in a balanced state and the ecosystem is more or less stable. This provides stability to the whole biosphere, which is fundamental to the continued existence and development of life on the earth (Dix, 1981).

Man-made or socio-cultural environment refers to the environment made by man through his various activities. Man interacts with the natural environment and converts it into a human habitat by arranging and changing his surroundings as best as he can to suit his wants. In this creative process the technical system under the influence of natural and societal conditions, have been instrumental (Wagner, 1960).

Today, with a rapidly advancing technology, man has started influencing the biosphere by changing some of the rules of nature and organizing the world of plants and animals in his own way. In his triumph, he has failed to realize the consequences of the final conquest (Jackson, 1976). In fact, we have reached a critical stage in the history of human civilization where we must pause and try to understand what has happened and is happening to the environment under man's impress. The effects of man on the environment are geographically varied and are historically cumulative. We should, therefore, always remember that resources on our planet earth are only limited and we do not have a second planet to plunder. Hence, we need to develop a favourable attitude towards the environment and try to live with nature instead of squandering and destroying our natural resources and also disrupting the ecological balance. For developing a favourable attitude towards the environment, which is the major goal of environmental education, the first step would be to know about the environment, in its totality. Whereas the biophysical aspects of the environment affect the growth and development of an individual or a community, the socio-cultural aspects (e.g. ethics, economics, politics, etc.) affect the behaviour of an individual or a community. Acquired

knowledge would help in developing genuine interest in the environment and its various dimensions providing the essential foundation and impetus to bring about attitudinal change.

3.2 Natural environment

The atmosphere

The atmosphere consists of a mixture of gases that surrounds the earth. It is held to the earth by the gravitational pull. An average sample of pure dry air consists of nitrogen (78 per cent), oxygen (21 per cent) and argon (0.9 per cent). Other gases, such as carbon dioxide, hydrogen, helium and ozone are present in small quantities. Besides these gases, the atmosphere contains variable quantities of water vapour in the lower layers.

The troposphere or lower atmosphere is in contact with the earth's surface. It is about 8 km high at the poles and 18 km at the equator. It contains varying quantities of water 1-4 per cent by volume. Most of the weather phenomena take place in this layer. Temperature in the troposphere decreases with height at an average rate of 1°C for 165 m.

The stratosphere is the next layer above the troposphere which extends up to a height of 50 km above the earth. Temperature remains constant in the lower part and then gradually rises. As this layer is free from clouds and associated weather phenomena, it provides ideal flying conditions for large jet aeroplanes. The stratosphere contains a rich layer of ozone which absorbs harmful ultraviolet rays from the sun and thus protects the biosphere.

The mesosphere is the third layer of the atmosphere extending to an altitude of 80 km above the earth. It consists of less gaseous mass and has no water vapour. Ozone is present throughout the layer.

The upper atmospheric layer is the thermosphere or heterosphere, which extends beyond 80 km. The layer contains no water vapour or ozone. The gases are found in separate layers, e.g. oxygen and nitrogen are most abundant between 80-115 km, hydrogen and helium at 500 km. Associated with the upper mesosphere and the lower thermosphere is the ionosphere, containing electrically charged particles called ions. These particles reflect radio waves back to the earth's surface and enable wireless communication.

The hydrosphere

The oceans, lakes, rivers and other water bodies on the earth form the hydrosphere. Water covers nearly 71 per cent of the surface of our planet. Water is essential for life and is important as a natural resource. It is a major body constituent of several plant and animal species. Seventy per cent of the human body consists of water. Regular intake of water, though in varying quantities, is necessary for living organisms to balance the losses. A maize plant, for example, requires 2.4 litres of water per day. Man requires a minimum body intake of water varying from 2.8 to 13 litres of water per head per day depending upon the climate and temperature. Water availability can, therefore, be a limiting factor on distribution of species.

Man requires water for his various needs such as personal hygiene, domestic households, industries, agriculture and electricity generation.

Although water is the most abundant liquid in the environment yet not all of it is available for use. Of the total water on earth, 97 per cent is salt water in oceans and seas, 2 per cent is frozen in ice-caps and glaciers and 1 per cent is fresh water, which is easily available and is suitable for human use.

Fresh water, therefore, is one of the most precious substances on the earth. In fact, mankind has the same amount of water on the earth that it had 1,000 years ago yet demands on this resource continue to soar with population increase and rising living standards. As such the sources of supply and the amount of water available are of crucial importance for the future.

Seventy per cent of fresh water on the earth is available in the form of surface supplies in lakes, rivers, waterfalls and in the atmosphere. The remaining 30 per cent is found as groundwater in aquifers, springs, geysers and wells. Natural water courses are the cheapest source of water supply. But these are also used for the disposal of waste effluents. Water, therefore, has to be treated before it is supplied to the public. Continued pollution will go on increasing the cost of pre-water supply treatment. In the future, we might, therefore, have less water available for our use due to increasing demand. Besides, the water treatment might also be more expensive due to increasing pollution.

The waters of the oceans contain salts in solution. The composition of sea water has favoured the origin of different life forms. Oceans contain a large variety of organic life - both plants and animals. These life forms are adapted to live at different depths and at different latitudes. These marine organisms provide an abundant source of food for mankind. In fact, oceans provide one-fifth of the world's annual protein and can help to supplement the world food supplies. Besides, oceans also contain deposits of several mineral resources.

The lithosphere

The lithosphere refers to the outer solid but thin crust of the earth surrounding the mantle. It is made up of lighter rocks called SIAL (silicate and aluminium main constituents) which overlies denser rocks, SIMA (silicate and manganese are the main constituents). The crust is thickest under the continents especially the high mountains and ranges between 30 and 75 km. It is thin beneath the oceans, from 6 to 8 km. The core of the earth is believed to be metallic, consisting predominantly of nickel and iron.

The material forming the earth's crust is known as rock. It is formed by combinations of various minerals. Silicate minerals are the most dominant. The average chemical composition of the earth's crust by weight is:

Oxygen	46.6%	Calcium	3.6%
Silicon	27.7%	Sodium	2.8%
Aluminium	8.1%	Potassium	2.6%
Iron	5.0%	Magnesium	2.1%

The lithosphere is made up of various types of rocks, which are generally classifed into three major groups on the basis of their origin. (1) Igneous rocks originate by cooling and solidification of molten magma. This process might take place either below the crust forming intrusive rocks such as gabbro and granite or above the surface forming extrusive rocks such as basalt. (2) Sedimentary rocks originate from the compaction and cementation of sediments deposited on the floor of seas or lakes. These rocks generally show a layered arrangement and include

rocks such as gypsum, chalk, rock salt and coal. (3) Rocks changed by heat or crustal pressures long after they have been formed are called metamorphic rocks. These include, marble, schist and gneiss.

The outer rocky crust which is broken up into plates floats over denser material. Internal heat provides energy for the movement of these plates causing great earth movements such as folds, faults, earthquakes and volcanic activity. These processes result in a variety of physical landscapes which are further modified by weathering and erosion.

The lithosphere is of great significance because of its soil cover which is indispensable for the growth of plants, which provide food for man and animals. The soil layer consists of a mixture of mineral matter such as sand and clay, as well as organic matter such as the decayed leaves, flower, minute bacteria and earthworms. Soil also contains varying amounts of moisture and air between the solid particles.

A well-developed soil is formed only when the weathered particles of rock remain undisturbed at one place for a long time. During such a long time, the action of physical, chemical and organic processes lead to the formation of well-developed layers one above the other. Each layer is distinguished from the other by its colour and the size of the particles. Soil formation is a slow process and it may take thousands of years to form the soil layers of a few centimetres in thickness suitable for cultivation.

The biosphere

The biosphere refers to a narrow zone where different types of organisms live on the earth - a little above and below the surface of the land and in water and air. It is a unique feature of the earth. Other planets probably do not have any trace of life.

The organisms in the biosphere vary in size, from minute bacteria to huge trees or large whales and elephants. These organisms may broadly be divided into the plant kingdom and the animal kingdom. The biosphere has an immense variety of living species numbering between 2 to 4 million species and over 4,600 million human beings, all belonging to one species - Homo sapiens.

The types of organisms and their spatial distribution vary depending on the physical environment. For example, tropical plant species such as cotton and rice cannot be cultivated in high latitudes. Similarly each animal has a certain habitat favourable for its life. When conditions become unfavourable, animals and birds migrate to other areas. Sometimes, when climatic conditions change too rapidly and some of the species are unable to adapt themselves to the changed conditions, they become extinct, as for example dinosaurs.

Man is also a part of the biosphere. He is dependent on plants and animals for food and other necessities of life.

Ecosystem and the natural cycles

The biosphere is usually divided into smaller units or ecosystems based on the similarities in the characteristics of the landscapes and the life forms they support. An ecosystem thus refers to the environment in a defined zone consisting of the abiotic (physical-chemical or non-living) components, e.g. soil, water and air and biotic or living components, e.g. plants, animals and micro-organisms of that particular zone.

All the plants and animals that live in a particular area make a community. In a community, the plants and animals interact with one another for food and shelter, as for example, when an insect eats the leaf of a tree or a snake shelters inside a hole in a tree trunk. Members of the community not only interact with one another but with the physical environment as well, for example, plants capturing the sun's energy for making food (photosynthesis).

There are two major ecosystems - terrestrial and aquatic. The terrestrial ecosystems are classified on the basis of the predominant type of vegetation. Forests, grasslands, deserts and tundra are the terrestrial ecosystems. The aquatic ecosystems are differentiated on the basis of chemical properties, for example, salt content. The aquatic ecosystems are fresh water, estuarine and marine. Most ecosystems contain a variety of organisms, for example, a deciduous forest can support over 100 species of birds and hundreds of species of plants, insects and small mammals (Dix, 1981).

Within an ecosystem, dynamic interrelationships exist between living forms and their physical environment. The relationships can be expressed as natural cycles which provide a continuous circulation of the essential constituents necessary for life.

What makes these cycles operational? We may recall from the principles of physics that energy is required for all types of works and movements. The survival of an ecosystem also depends on a continuous energy flow through it. Let us now see how energy flows in ecosystems and makes them function.

Energy flow in the ecosystem

Survival of all living things depends on the circulation of energy. Human beings and animals get energy from the sun. Thus, radiant energy in the form of sunlight is the ultimate and only significant source of energy for any ecosystem (Kormondy, 1976). Some of the sun's energy has been stored in coal, peat, petroleum, natural gas and other fossil fuels. The flow of energy from the sun to the biosphere is uni-directional as it does not go back to the sun. It is important to consider how much and what kinds of radiant energy reach the earth's surface since they largely determine the conditions that govern life.

Only a small portion of the sun's tremendous energy output (1 in 200,000,000 parts) reaches the earth. The radiant energy reaching the earth's surface is two calories per square centimetre per minute. The incoming solar radiation is called insolation. It is received in the form of short electromagnetic waves. A part of insolation is absorbed by the water vapour, ozone and some other gases in the atmosphere. A considerable amount of insolation is reflected back into the space by the clouds in the atmosphere and ice caps, snow fields and water bodies on the earth's surface. Only 51 per cent of insolation reaches the earth's surface.

Distribution of insolation on the surface of the earth is not uniform. This is primarily due to the spherical shape of the earth and the revolution of the earth around the sun with its inclined axis. Maximum insolation is received in the tropical zone lying between the Tropic of Cancer and the Tropic of Capricorn. In this zone the sun's rays are vertically overhead during a part of the year.

The regions between the Tropic of Cancer and the Arctic Circle (23°30' N to 66°30' N) and the Tropic of Capricorn to the Antarctic Circle (23°30' S to 66°30' S) are called the temperate zones. In these zones, the sun's rays are never overhead during the year. In this region, the angle between the sun's rays and the

surface of the earth decreases with the increase of latitude owing to the spherical shape of the earth. The oblique rays are less effective in heating the surface of the earth. This region has, therefore, less amount of insolation.

In the polar zones, during a part of the year, the sun's rays are not received at all and the sun is not seen at all. However, some compensation is made by extremely long duration of the sunlight in the summer. Yet this compensation is insignificant since the outgoing radiation is much more than the incoming solar radiation. There is transfer of energy from lower latitudes to middle and higher latitudes by the circulation of air in the atmosphere and water in the oceans. It is the amount of solar energy available within a region that primarily governs the productivity of different species. This explains to some extent why the hot and sometimes humid tropical region is more productive than the cold and dry tundra region.

Latitudinal patterns of energy distribution and heat balance on the earth provides just one example of energy flow in the abiotic component of the environment. Flow of energy through an ecosystem (mainly the biotic components) is well explained by food chain.

All organisms need food as a source of energy for growth and reproduction. On the basis of their abilities to prepare/procure/consume and transform the food, organisms may be divided into three major groups: producers, consumers and decomposers.

In a food chain, all the green plants, including blue-green algae and some bacteria form the first link, as they manufacture their own food from inorganic substances with the help of solar energy through the process of photosynthesis. Because they can make energy-rich organic compounds or food, such organisms are called producers. They in turn are eaten by plant-eaters or herbivores such as insects, cattle, etc., which make up the second link in the food chain. The third link is composed of the carnivores - the animals which eat the herbivores. They, in turn, could be food for other carnivores as occurs when hawks eat snakes. Some of the species are called omnivores because they are both herbivores and carnivores. Man comes into this category as he feeds on both plant and animal products. Eventually, all plants and animals die and their bodies are broken down and consumed by organisms like bacteria, fungi and earthworms. These organisms help in decomposition of dead plant and animal tissues and absorb the decomposed products as food. These are, therefore, known as decomposers, which make the next link of the food chain. These decomposers convert the organic matter into inorganic mineral nutrients. These nutrients are absorbed by the plant roots for their food, and the food chain is completed.

Simple food chains do not exist in any ecosystem as each organism may feed on a variety of food derived from various organisms and in turn may be eaten by a number of organisms. Many simple food chains intermingle with one another to form a food web.

In the context of energy, we may recall the two laws of thermodynamics that govern energy changes. The first law states that energy cannot be created or destroyed. It may be transformed from one form to another e.g. in photosynethesis solar energy is transformed into chemical energy.

The second law states that when energy is transformed or transferred a certain amount of energy assumes a form that cannot be passed on or changed further. As such no energy transformation is 100 per cent efficient and some amount of energy (mainly as heat energy) at the time of conversion or transfer becomes unavailable

for any more transformation. This is called energy degradation or loss. For example, when transfer of energy takes place along the food chain, only about 10 per cent of the chemical energy available at one link in the food chain is transferred and is made available to the next link. Energy once degraded and lost as heat cannot be reused and must be replaced.

We should, therefore, remember that to a consumer, such as man, only net energy counts and this applies to all energy, food and fuel. Gross energy, as a potential, is often very impressive in quantity, but must always be evaluated in terms of the amount that can be converted into the desired work. For example, the gross energy of solar radiation is huge, but the net energy of food is very small. Likewise proven reserves of oil and coal are gross energy. If the cost of conversion is more than the final product in these items, there may be no net energy (Odum, 1975).

Natural cycles (biogeochemical cycles) and limiting factor concepts

All life on the earth depends on six essential chemicals - carbon, oxygen, hydrogen, nitrogen, phosphorus and sulphur. Together these six elements make up more than 95 per cent of the matter of all living organisms. Besides, other elements such as iron, manganese, copper and iodine are also required in smaller quantities. Unlike energy flow, most materials flow from the abiotic to biotic and back to the abiotic components of the earth's ecosystem in a cyclical manner. These cyclical movements of matter are called natural cycles which are also called biogeochemical cycles. These help to bind the ecosystems together.

The materials or nutrients flow in a closed system since these elements are in fixed supply and are cycled and recycled within the earth's ecosystems.

Vast quantities of the major elements are found in large reserves in the atmosphere (e.g. carbon, oxygen and nitrogen) and in rocks (e.g. phosphorus, carbon and sulphur). Only two of these cycles are being given here as examples to illustrate their cyclical movements.

Carbon cycle - Carbon is the basic constituent of the large molecules characteristic of living beings. The major reservoir of carbon is the gas carbon dioxide, which occurs in the atmosphere of our planet and in solution in its water. Carbon as CO_2 is withdrawn from the 'pool' of carbon dioxide in air and water by plants through the process of photosynthesis for building carbohydrates and other organic compounds. These compounds transfer the carbon to herbivores, which eat the plants. When herbivores are eaten by the carnivores, the carbon moves farther along the food chain. At various positions along the food chain, CO_2 is returned to the 'pool' through respiration by both plants and animals. Carbon is also returned to the 'pool' through the agency of the bacteria and fungi that cause decay. These micro-organisms serve as the ultimate link in food chains, reducing the complex carbon - containing molecules of dead plant and animal matter and animal wastes to their simple components.

Some amount of carbon extracted from the CO_2 pool by photosynthesis does not return to the 'pool' through respiration and decay and leaves the carbon cycle for millions of years and enters the crust of the earth. This happens when incompletely decomposed organic matter accumulates and is transformed by geologic processes into fossil fuels - coal, oil and natural gas. Carbon is also withdrawn temporarily from the cycle by the formation of limestone. Such carbon is returned to the CO_2 pool by the burning of fossil fuel and by the weathering of limestone rocks.

Phosophorus cycle - Phosphorus is one of the constituent elements of all living organisms. Plants obtain inorganic phosphate from the soil. It is transferred as organic phosphate to consumers and decomposers. Through decay and decomposition, it returns back to the soil, rivers and lakes and from there to the oceans. Most of the phosphate forms insoluble deposits in the ocean bed and remain unavailable until geological movements uplift these sediments and weathering helps in their disintegration. However, an important pathway of phosphorus back from the sea to the land occurs with fish-eating birds. For example, on the west coast of South America where upwelling of ocean currents bring nutrients laden sediments of the bottom to the surface, surface dwelling fishes thrive well. They in turn support large numbers of fish-eating birds. The deposits of their excreta are important sources of phosphate.

Like carbon and phosphorus, nitrogen, oxygen and sulphur also move in the biosphere in a cyclic form.

The hydrological cycle

The hydrological cycle is a continuous natural process whereby water is changed between the atmosphere, the lithosphere, the hydrosphere and the biosphere. Water from various water bodies evaporates owing to the impact of the solar radiation and enters the atmosphere as water vapour. Winds transport the water vapour in the atmosphere from one place to another. Condensation may take place in the atmosphere and water may precipitate as rain or snow on to land and water surfaces. Precipitated water on the land surface percolates into the soil as groundwater. Within the ground, there is always a natural water level or water table. The soil below this level is saturated with water. However, groundwater is not static. It moves in various directions. It moves up through the soil from the water table and provides a continuous supply of water to the surface layers of the soil, where it is absorbed by plant roots. Some water from the plants evaporates by the process of transpiration, through leaves. Water also emerges from the ground in the form of springs or lakes. In areas of porous rocks, it forms underground lakes or reservoirs. Not all the water precipitated on land percolates into the soil, especially where the rainfall is high. Surface water as run-off flows into streams and rivers.

Natural evaporation from the oceans is 420 Tm^3 (1 m^3 equals 1,000 litres, and 1 tera cubic metre i.e. 1 Tm^3 equals one million million cubic metres) annually. It exceeds precipitation by rain into the seas (380 Tm^3) by about 9 per cent. This 9 per cent of evaporated water from the oceans moves as water vapour over the land surface and precipitates. Eventually this water returns back to the oceans as surface run-off (40 Tm^3). Precipitation over land (120 Tm^3) exceeds evaporation from land (80 Tm^3) by 9 per cent, which is compensated by the movement of water vapour in the atmosphere from oceans to land surface by the same amount. Thus, the hydrological cycle consists of a balanced continuous process of evaporation, precipitation, surface run-off, groundwater movements and transpiration (Dix, 1981).

Residence time (the period a water molecule stays at a particular stage of the water cycle) of water in different parts of the hydrological cycle is of great importance as this provides the account of net availability of water for various uses. Besides. water carries with it other elements in the dissolved form. Residence times are, therefore, important in the transport of nutrients. Residence times vary from nine days to about 10,000 years depending on the location and the physical state of water (refer Table I).

Table I

Residence time of water molecules in the hydrological cycle

Location	Residence time
Atmosphere	9 days
Rivers	2 weeks
Soil	2 weeks to 1 year
Large lakes	10 years
Shallow groundwater	10's to 100's years
Oceans	120-3,000 years
Deep groundwater	Up to 10,000 years
Ice caps	10,000 years

Only a very small amount of total water in the ocean is active in the hyrological cycle at any one time, and yet this small amount of water is tremendously important in facilitating the movement and sorting of chemical elements in solution (geochemical cycle), sculpturing the landscape, weathering rocks, transporting and depositing sediments and providing our water resources.

The rock cycle

Throughout the five billion years of earth history, the materials on or near the earth's surface have been created, maintained and destroyed by numerous physical, chemical and biochemical processes. The three rock families - igneous, sedimentary and metamorphic, which constitute the lithosphere, are involved in a worldwide recycling process called the rock cycle. For this cycle to operate, internal heat provides much of the energy. Besides, the geochemical cycle is required for materials and the hydrological cycle for water. Water is involved in the processes of weathering, erosion, transportation, deposition and lithification of sediments.

Internal heat drives the rock cycle and produces molten materials, which cool and solidify to form igneous rocks. These may crystallize beneath or on the earth's surface. Rocks at or near the surface break down chemically and physically by the agents of weathering and erosion to form sediments. These are transported by wind, water and ice. The sediments accumulate in depositional basins, such as the oceans. Eventually, they are transformed into sedimentary rocks. After the sedimentary rocks are buried to sufficient depth, they may be altered by heat, pressure or chemically active fluids to produce metamorphic rocks. These may again melt under the impact of internal heat to start the cycle. However, variations are possible in the idealized sequence (Keller, 1976).

The rock cycle is important for concentrating as well as dispersing materials. Man extracts minerals from such concentrations which have been produced in this cyclical process.

In the natural state, there is a perfect harmony between the various cycles and flow of energy establishing a dynamic and fluctuating equilibrium. This is known as ecological balance, which is necessary for the continuation of life.

Man in the biosphere

Although man is only one among millions of living forms, the unique characteristics that he has acquired in the organic evolution have given him a dominant position in the biosphere. Like other organisms, he is intricately connected with

the ecosystem/biosphere and is bound by the overall limitation of the physical environment. However, his progress from primitive man to technological man has changed him from a 'creature' of the environment to become a 'moulder' of the environment.

Man depends on the natural environment to satisfy his basic needs of food, shelter and clothing. Different elements of the natural environment acquire meaning and value with reference to the needs of man and the stage of cultural and technological development of man living in a region. For example, the trees yielding rubber in the Amazon basin had no resource value until man found the utility of rubber for various purposes. Similarly low grade iron ores acquired resource value only after the development of a new process which could make use of such ores at a low cost.

As such, a natural resource may be defined as an attribute of the natural environment assessed by people to be of value in satisfying their needs or wants.

Natural resources may be classified in a number of ways. They may be classified on the basis of their sources of origin such as land resources, water resources, etc. Another widely used classification scheme is that of renewable and non-renewable resources, which is based on the nature of availability of resources. Some resources, like forests, may be obtained continuously year after year since they are not exhausted. These are, therefore, called renewable resources. Some resources may get exhausted after few years of use, for example, oil-wells and coal-fields are abandoned after a few years. These are called non-renewable resources.

Several resources of the earth are non-renewable and are in limited amount. Hence, the future availability of resources is an important question. Unfortunately it is difficult to answer this question since we estimate the quality and quantity of resources with the present level of knowledge and make predictions about the availability of a particular resource on the basis of assumed consumption in future. Changes in our technological skill and discovery techniques may, therefore, bring substantial changes in the resource availability and may improve the situation. On the other hand, any increase in the rate of consumption over the assumed rate would reduce the estimated period of resource availability.

Basically, our present resource problem is related to population problem, for it is impossible to maintain an ever-growing population on a finite resource base (Keller, 1976).

Human population

Size, growth rate, distribution and age structure of the world population have important relationships to environmental problems. For example, over population in some parts of the world has posed tremendous pressure on the natural environment causing its over-exploitation. There has been an increase in deforestation due to ever-increasing demand for fuel-wood as well as for farming land. In such areas, even the human population is subjected to the worst environmental degradation due to undernutrition and bad health conditions. Problems thus arise both from over use of land and inappropriate crops and from pollution and misuse of water (Sigal, 1977). However, it is impossible to establish a resource management policy based on contracts such as protection or limited utilization of the environment under conditions of strong inequality. The social structures that generate such inequalities need to be altered.

For any evaluation of environmental changes and prospects, it is of great importance to know about the human population, its size, rate of growth, distribution and age structure.

Size and growth of human population

In the last few decades, the human population of the earth has increased rapidly. Half-way through the nineteenth century, the world population was estimated at one billion people, it took several thousand years of human existence to reach that point, but in 1980, it was estimated over four billion (United Nations, 1981). By the year 2000, it is estimated to grow to about eight billion.

Although the population of the world has been increasing constantly, the rate of growth has diminished slightly. During 1960-1965, the average natural growth rate for the world was 1.99 per cent. It came down to 1.72 per cent during 1975-1980.

The change in population or natural growth rate is determined by the difference between the birth rate and the death rate. It is generally expressed as a percentage. If the value is positive, there is growth, if negative, there is a decline. It is calculated as the following.

$$\text{Annual population change rate} = \frac{\text{Birth rate - death rate}}{10}$$

The number of births and deaths per thousand are called birth rate and death rate respectively. Change in population depends on the difference between the two rates.

In developing countries, high crude death rates fell rapidly after the Second World War and by 1980 were at a comparatively low level of 11.4 deaths per 1,000 population per year. Crude birth rate fell in some areas, but still it had an overall average of 33 births per 1,000 population per year. As a result, this region showed a high growth rate of population i.e. 2.16 per cent annually. In developed regions, on the other hand, the annual growth rate was 0.7 per cent annually with an average birth rate of 16 per 1,000 and a death rate of 9 per 1,000.

In addition to birth rate and death rate, another important factor associated with population change is fertility rate. It is the average number of children a woman will have during her reproductive period (ages between 15 to 45 years). In recent years the total fertility rate for the world has been nearly five children per woman. If the world is to reach a target of zero growth rate of population, the total fertility rate would need to be about an average of 2.5.

Age structure

Of the total population, percentage of people in different age-groups reflects the age structure. A predominantly young population (age-group 1-14 years) calls for greater expenditure both on the part of the family and the State. Moreover, when they enter into the reproductive age-group the population would increase at a much faster pace. Recent statistics indicate that more than one-third of the world population belongs to this age-group. As such in years to come even if they have a lower fertility rate than their parents, there will be continued growth of the human population.

The above-mentioned factors relate to population change, which has been dramatic in recent years. However, all parts of the world do not have either the same number of people or the same growth rate of population. The extent to which people are scattered over a region or a country is called the population distribution. Due to unfavourable climatic conditions, some of the areas e.g. deserts or snow-covered regions, may be uninhabited or may have very few people. On the contrary, areas with a suitable climate may contain a large population. Nearly three-fourths of the world population live in the developing countries of the world.

The distribution pattern gives only the idea of the number of people living within a particular area. Two countries having a different surface area may have the same population, which may give rise to quite different living conditions. The number of people per unit area indicates the intensity of population distribution and is called population density. It is obtained by dividing the total population by the area it inhabits. However, these density figures may be misleading, if they are calculated for large areas encompassing vast stretches of uninhabited parts. For example, the average density of population for the world is 30 persons per square kilometre. One may, therefore, conclude that the world does not face any population problem. One should be cautious while making such generalizations. Besides, one should also keep in view the scientific and technological advancements as well as productivity of the regions under consideration while comparing the density figures. Density of population is highest with more than 50 persons per square kilometre in southern and eastern Asia, Europe and eastern parts of the United States.

There has been large-scale internal as well as international migrations of unskilled and semi-skilled labour, and professional manpower due to imbalances in income and employment opportunities. The other group of migrants consists of refugees who have been displaced by wars and political upheavals. It is estimated that in this century about 250 million people have left their countries due to wars and political upheavals (Brandt Commission, 1980).

It is thus apparent that distribution of human population on the earth is very uneven and so is the distribution of resources. However, there is one basic difference between the two and that is that human population is growing at an alarming rate but the earth's resources are limited. As such, it is in man's own interest to frame developmental policies so as to ensure a better quality of life not only for the present generation but for generations to come. He should not forget that his increasing interference with the natural environment has several repercussions on the biosphere at large. For example, irrigation seems to be an appropriate measure to be adopted in dry parts of the world. But sometimes it can seriously upset the environment. Construction of a dam across the river Indus in the 1880s helped in the watering of the rainless desert of Pakistan. But the heat of the sun constantly evaporated water from the surface of the soil. As a result, the mineral salts of the river water, started accumulating in the soil. Salinity increased so much that the soil turned unsuitable for plant growth and the crops failed. Attempts to wash out the salts further worsened the situation since it caused waterlogging (Jackson, 1976). Similarly if the complete ecosystem is not considered in planning a scheme, it may have devastating results.

Man should, therefore, function within the limits of the biosphere to ensure his future survival. He should use science and technology to function more efficiently within the limits. To function within this limit, he should also know the form, structure and pattern of development of human societies. These would help him gain insights into the nature of various environmental problems and find solutions for them.

3.3 Man-made or socio-cultural environment

Like the natural environment, the man-made or socio-cultural environment is also regarded as a whole set of interlocking systems. It thus refers to all the physical infrastructures built by man and the social and institutional systems which he has developed. In other words, all the creations of man come under this category. The socio-cultural environment, therefore, includes historical, cultural, economic, political, moral and aesthetic aspects of human life. It is of great significance because it conditions the behaviour of the human beings. Besides, it has been developed as a result of human interaction with one another as well as with the natural environment.

Nature has considerable effect on man. He lives as a member of natural communities. He depends on plants and animals for his sustenance. Besides, he interacts with other individuals because man is basically a social animal, hence, social relationships are obligatory for fully 'human' man. There is a great variety of possible social bonds and all of them do not define the same kinds of human groupings. Linguistic, religious, territorial, economic and other divisions intersect or overlap each other (Wagner, 1960).

Groups of men, organized in different ways and using different means, modify and utilize the environment for satisfying human wants. Ordinarily, these wants include food, clothing and shelter. However, they also appear to include many other things that are matters of preference and which vary from one human group or society to another. Besides, the nature of human wants also changes with time in a particular region with the technical development.

Man's interaction with the environment, his growing abilities and hence his changing role in the environment may be well explained through the history of human civilization.

Historical perspective of man-made environment

When man evolved, he was the most defenceless creature in terms of physical capabilities. However, nature provided him with a highly developed brain, which compensated for his other physical drawbacks and he could fight with natural hazards and survive.

Primitive man was simple. He had only a few basic needs for which the available resources were in plenty, though scattered. He had, therefore, to move from one place to another in search of food to satisfy his basic urge of self-preservation. Man was basically a food gatherer and was totally dependent on the natural environment.

Gradually, man's intelligence helped him to improve his survival techniques. He evolved the use of stones, stone tools and fire. This increased his limited sphere of activity from being just a food gatherer to that of a hunter as well. Stone-age man like other animal species learnt to live in the environment bound by the harsh natural laws in the environment. But man's special gifts such as speech, organizing ability and his erect posture coupled with his operable thumb helped him to exchange ideas and thoughts and put them into practice to escape from nature's fierce grip.

His experience taught him to grow crops. This gave him stability to live for longer periods in one area; instead of having to migrate from one place to another. Still, there are many tribes which follow their ancient traditional pattern of life and live within the bounds of the natural life cycles of the environment. They do

not disturb the natural ecological balance, since they do not want either to over kill or gather more plant products for use than necessary. The Bushmen of Africa and some Australian Aborigines living in remote areas are probably the nearest examples.

In the forest areas, the shifting agriculture was used by the new stone-age people to grow crops. In this method, trees were cut down at the ground level and were left to dry out. Afterwards they were burnt. In the cleared area, crops were grown by scattering seeds. After two or three years when harvests used to get smaller because the soil was exhausted, the community moved to the nearby area and the same farming practice was repeated. Dayaks of Borneo in the East Indies, still follow this method of farming (Jackson, 1976).

In more fertile river plains, man led a more settled life. This left him with more time to devote to other spheres of life. The earlier successes in taming the natural environment to some extent, had given him more confidence. He kept on improving his techniques. His aspirations grew with each success. Thus in his pursuit to make his life more comfortable, new discoveries and inventions took place.

Some of the discoveries such as the steam engine, spinning jenny, electric dynamos etc. revolutionized the society. Use of power and machines increased the productivity - both in agriculture as well as industry. Improved agricultural techniques increased the agricultural production. With more efficient farming methods, few people were required for the jobs on the farm. Peasants were thus forced to leave the farm and were unable to make a living. Hence, they sought work in the city. Migration to urban areas was on a large scale. Competition for jobs was also acute in cities and, therefore, labour was cheap.

This was an age of technology and industry. Power-driven machines replaced much of human efforts and industries could produce on a large scale. New factories were established. Since the labour was cheap factory owners paid a bargain price for the labour without any regard for the welfare of the employees. Working conditions in the factories were not at all satisfactory. There was no legislation to check the labour exploitation.

Scientific and technological developments helped in reducing the death rate and increasing life expectancy. Population explosion was, therefore, under way. The population of Europe, according to United Nations estimate, more than doubled between 1800 and 1900. The population growth was very high not only in urban areas but also in rural areas. This further forced people from rural areas to migrate to urban areas in search of jobs.

Cities were not built to accommodate such a large number of migrants. Housing facilities were inadequate. Several families lived together in attics, cellars or a room. Living conditions were abominal and unhygienic. Water was a luxury. Epidemics ravaged the city more frequently. However, medical technology gradually helped in controlling several diseases which allowed the population to swell.

The industrial revolution had other far-reaching consequences. The feudal society of the Middle Ages consisting of aristocracy and peasantry gave way to a new social order - an order of capitalist and labourer (Treshow, 1976). Gradually trade unions emerged. Working and social conditions together with wages for the labourers improved. The higher wages generated increased purchasing powers, and hence, a rise in living standards. But more consumers meant heavier demands upon the environment.

Nevertheless, industrial activities have been key factors in raising the standards of living in most parts of the world and therefore developing nations have been making efforts to achieve fast industrial growth.

Development of a modern transport system is closely linked with the industrial and urban growth of the eighteenth and nineteenth centuries despite the fact that means of transport have constantly been improving throughout the ages. Early modes of travel had little impact on the environment. But the more recent rail, road and air transport system developments leave a lasting effect on the environment in several ways. These facilities consume large land areas. They use resources such as metals and energy which are available in a limited amount. Besides, they pollute the environment by discharging pollutant into the air and water as well as by causing noise and vibrations.

The industrial revolution helped the Western civilization to improve its material wealth. But other parts of the world did not flourish the same way, since such developments did not take place all over the world simultaneously. Societies or countries with a higher level of scientific and technological advancements could use the resources more efficiently in creating wealth. Such affluent societies consumed resources in ever-increasing quantities.

Nevertheless the resources of the earth are widely and unevenly distributed. As such even industrialized and developed nations had to depend for certain resources on other countries which were not so affluent. Gradually the industrialized nations started dominating the less industrialized countries of the world by colonizing them. Such developed countries exploited the resources of their colonies for their factories. For example, raw materials for the factories of Western Europe were drawn from as far as India, Japan and African countries. Colonies were also used as a market for their excess products.

New international economic order and equitable distribution of resources and wealth

The huge monopolies created by industrialized countries are so big that they continue to dominate the course of economics for the other non-industrialized countries. Exploitation of this type continues to widen the economic gap between the industrialized and non-industrialized countries. The majority of world population still lives below the subsistance level. Through the mechanism of economic dependence, 15 per cent of the world's population controls 55 per cent of the world income (Treshow, 1976). Historically, such a vast contrast in affluence and poverty has never coexisted. Our civilization has reached a point where a decision has to be made to redefine human progress in terms of distribution rather than growth alone.

The Third World countries are, therefore, demanding a new international economic order, which is basically a demand for equality. Despite being politically independent, the developing countries find themselves economically dependent on developed countries. Trade, financial flows and technology are the three key elements of this economic dependence.

Although colonization has largely gone, the trade pattern of the colonial days is still continuing. Whereas the developed countries export manufactured products, the developing countries export raw materials. Over the years the prices of manufactured products have increased faster than the price of raw materials. As a result the purchasing power of the developing countries has been going down and the developmental process has been hampered. The two prices, therefore, need to be linked for improving the purchasing power of the developing countries.

Like trade, financial flows in form of 'aid' provided by developed countries to developing countries restricts their economic development. For buying certain goods from the international market to meet the domestic needs, the developing countries need money, which they do not have in sufficient amount. Hence they need aid from the developed countries. In order to pay back the loan, they should sell their products in the world market. But the developed countries have imposed restrictions to the entry of several such products in the markets of their countries. As a result the developing countries have to borrow again to pay back the loan. Besides, 'aid', giving countries dictate certain terms and conditions to the recipient countries such as spending the aid money in the donor's country only or using this money only for certain items. This naturally controls their conomic independence.

Similarly, technology is also a key element. It helps in the developmental process. However it does not only mean machinery. It grows out of a social and economic environment, which is designed to the need of a particular society. Technology of developed countries may not be suitable for developing countries, but the developing countries do not have much choice since their indigenous base was crippled during a long colonial period. Hence, they have to depend on developed countries, who charge very high prices and also put a number of conditions to keep them under control. For example, they limit volume of production, dictate the source of supply of raw materials, spare parts and intermediate products.

Many economic problems of the developing countries such as poverty, unemployment and lack of industrialization are the outcome of prevailing economic order. For reducing the global disparities it is therefore necessary that the rich nations, who have historically been in an advantageous position of being better off, take a liberal view towards the development of less affluent nations. No nation should develop at the expense of others. It is only through co-operation among nations of the world that we can frame suitable environmental policies for judicious utilization of resources which would benefit all of humanity and would raise the quality of life for everyone.

It is thus apparent from the analysis of environment - natural and man-made, that man has constantly been interacting with the natural environment for his various needs. In the process he has created a socio-cultural environment which has been ever changing in accordance with the human needs and human adjustments with the natural environment. The primitive gathering and hunting society, the early agricultural society and the present industrial-technological society, all represent adaptations to the environment.

Some of the ways in which man has tampered the natural environment leading to environmental degradation may be summarized as the following:

(a) For farming, timber and fire-wood, man has deforested vast areas without replacing these areas with similar vegetation cover or a system of farming which would help in maintaining the fertility of the soil. This has, therefore, led to serious soil erosion, and loss of valuable flora and fauna. It has been estimated that about 3.34 million acres of land in India is under shifting cultivation practised by the tribal people (Vidyarthi, 1975).

(b) Unrestricted overgrazing has destroyed vegetation cover and productive soils in many parts of the world, for example, the nomadic herders on the fringes of the Sahara desert are causing the desert to spread southwards towards the tropical grasslands.

(c) Excessive use of fertilizers and pesticides have badly affected the natural cycles. Certain chemical used as pesticides are harmful to man as well. They find their way into our food and water from the soil and the rivers.

(d) Industrial activities have their impact on the natural environment in two ways. Mineral mining in many areas have led to ugly scars on landscapes since many abandoned mining sites are unsuitable for vegetation growth and they have been turned into waste lands.

Wastes from the industries are released into the atmosphere (gaseous) or dumped on land (solids), or discharged into streams, rivers, lakes or seas (liquids). As such environment is polluted to a great extent. For example, factories producing soda give rise to very serious atmospheric contamination especially with hydrochloric acid gas. Some of the industrial goods such as disposible articles made of plastic present difficulties in disposal because they are not quickly affected by bacteria. As such they do not rot away soon.

(e) Growth of urban settlements has greatly affected our natural environment. It has been estimated that a million acres of living soil are taken over annually for erecting man's buildings (Jackson, 1976). Besides, tremendous quantities of water are needed by human settlements for domestic as well as industrial uses. The contents of urban sewers are discharged into streams and rivers polluting the water.

(f) Various means of transport do not only consume vast stretches of land but they also consume different sources of energy such as coal, diesel and petroleum in large quantities. Besides, these means of transport pollute the environment in different ways. Motor vehicles alone are responsible for 60 per cent of air pollution. The carbon-monoxide and lead are emitted from motor vehicles which are extremely dangerous to human health. Aircrafts, like other forms of transport, are users of fuel oil. They pour huge quantities of polluting fume into the air.

(g) Although human societies are founded upon co-operation, competition between groups is also a human characteristic. Wars and the threat of war have always been a part of the history of human civilization. But in recent years, the advancements made in the field of science and technology have increased the destructive power of modern weapons. Several factors such as economic, political, ideological and religious, underline the growing regional conflicts in the present-day world. Between 1945 and 1979, about 81 nations were involved in 130 civil and regional conflicts causing widespread suffering and disruptions. By 1980 global military expenditure has increased 30 times since the turn of the century. These activities involve vast human and natural resources. Some raw materials including bauxite, copper, lead and zinc were especially in demand for military uses. Besides, military activities have their impact on ecosystems in several ways. Vegetation disruption accompanied by soil erosion and alterations to the hydrological regime may affect the original ecosystem in such a way that restoration might be difficult (Robinson, 1979). Despite widespread condemnation of nuclear weapons, 469 nuclear explosions mostly to test weapons have been reported between 1970 and 1980. During the 1970s several studies were carried out on the potential effects of nuclear war, which suggested that a major conflict would kill 200 to 300 million people. It would also destroy most of the economic resources of the super powers (Holdgate, et al., 1982). Natural ecosystems would be affected. Environmental changes could be of comparable long-term significance (United Nations, 1968; NAS, 1975; SIPRI, 1977).

3.4 Environmental ethics

Most of the environmental problems of the present-day world are essentially man-made. The role of man is, therefore, crucial because it is his attitude towards the human and natural environment that has shaped the present-day environment. Obviously it is only through the change in his attitude that he can take initiatives in influencing the conditions of the environment. Man's attitude and behaviour are directly related to the value system of the contemporary society. Historically, individual and societal values have not always been in the best interests of preserving a quality environment (McCabe, et al., 1977). The present-day environmental crisis obliges man to re-examine his values and where necessary alter them in order to ensure man's survival. We must formulate a value system of ecological priorities to become the laws of the world.

Man must realize that every human being has a right to live and fulfil his basic needs. If man could live in harmony with nature and could act as a responsible 'caretaker' or 'guardian' of the environment, it is possible to attain an ecologically sound future for generations to come. Man with his unique technological power has a profound effect on his environment. Therefore, he can control, to some extent his own destiny.

For living in harmony with the environment, man has to evolve a balanced way of thinking, feeling and acting towards the environment.

An environmental ethics is basically a human ethics based on social justice for all without discrimination of caste, race, sex, religion, ideology, region or nation.

3.5 Environmental decisions

Decisions affecting the environment may be made by an individual, a family, a society, consumers, industries and the government. Such environmental decisions may be taken on the basis of prevailing hierarchy of values without having any ecological consideration. For example, in the present century, technologically advanced societies have regarded a steadily improving standard of living for their people based upon economic growth and industrial development as their main collective value. Ecological considerations have had a low priority. Since these societies failed to reckon with the long-range consequences imposed by their hierarchy of values, the quality of man's environment has degenerated.

Effective environmental decision-making involves consideration of various issues. Ecological, economic, social and technical aspects must be carefully analysed. Besides, various alternatives in policies, actions and practices must be examined before taking a decision. This would help in framing sound developmental policies which would not only enrich the lives of the people from all socio-economic sections of the society but would also maintain a quality environment. One feels relieved to see that developing countries like India are giving emphasis on due stress to the overriding concern for ecological security. The Indian Constitution through its Directive Principles (Articles 48 and 51A) declares that the protection and improvement of the natural environment (including forest and wildlife) is an obligatory responsibility of the State and of every citizen of India.

Individuals and groups may contribute significantly towards formulation of sound environmental decision-making. Justice Nagendra Singh, President of the Indian Academy of Environment Law, Conservation and Research, has suggested that as environmental protection is of national importance, Parliament should initiate legislation to cover all aspects of environmental pollution throughout the country

in an integrated manner. As these measures would include many subjects in the State list there are only a few subjects in the concurrent list directly relating to environment, he feels a specific entry should be made in the central list on the subject so that the legislative measures and executive actions can be taken by the Centre. Such individual suggestions, if given weightage, can surely guarantee the effectiveness of environmental law and thereby make environmental protection meaningful for the whole country (Agarwal, et al., 1982). Whenever the people have organized in a group to protest and challenge the short-sighted developmental activity, they have compelled the government to act. For example, the Kerala Sastra Sahitya Parishad, a well-known organization in India, led the battle against the silent valley hydroelectric project. Finally, the government had to drop the project. This is a unique movement of people. The basic philosophy of this movement is that popularization of scientific understanding of environmental science among the masses can become a powerful tool for speeding up the development process and pushing it into appropriate directions. Similarly, citizens' groups and environmentalists have protested against the sitting of the Thal-Vaishat fertilizer project near Bombay.

CHAPTER 4

PROBLEMS OF THE ENVIRONMENT AND MEANS AND WAYS OF THEIR SOLUTION

Man's activities have affected the environment in a number of ways. As we have gone through earlier parts of the module, we have seen that man's ability to exploit the environment has resulted in modified ecosystems in many parts of the world and has given rise to a number of problems. For example, increase in salinization or spread of water-borne diseases or malaria have been reported from the areas served by new irrigation projects. Similarly, nature's self-building processes and natural cycles have often been disrupted by human activities. For example, water's ability to cleanse itself is a natural process. However, man through disposal of waste has often polluted water to the extent beyond the state of self-purification.

The nature of environmental problems are different in various parts of the world. In developed countries, environmental problems mainly relate to pollution, fast depletion of several natural resources and overall damage to the ecosystems. In developing countries, environmental problems are quite different from the developed countries. In these countries, energy and resource consumption is not high and pollution problems - if any, are mostly localized. But here are the problems of poverty, diseases, lack of adequate housing, clean drinking water and safe disposal of human body wastes. High population levels and growth rates are the causes of many such problems. The search for fresh agricultural and grazing land, the depletion of forests for timber and fuel and the intensified use of chemicals for pest control, pasture improvement and crop productivity, all combine to degrade the environment (Collins, 1984). Many problems confronting the developing world today, had been encountered by developed countries earlier, mistakes of which may be avoided. Environmental concern should not be a barrier to development, rather it should form a part of the development so as to make it enduring and free from unwelcome side effects.

A degraded state of the environment poses serious threats to the well-being of ecosystems as well as the very survival of the human race. Many voices have been raised in alarm over the environmental crises. An environmental crisis may be defined as a situation demanding immediate corrective action - if such be possible - to avert deterioration, damage or destruction of the affected system (Strahler and Strahler, 1977). These crises may be local, regional or global. Most of the environmental problems facing mankind today, whatever may be their magnitude, have developed due to our own negligence. Had society chosen to apply the principles of science and technology that have been at our disposal, in an appropriate manner, we might have headed off most of these troubles. We have now at least realized the dangers and have started responding to overcome the environmental crises.

Environmental problems may be classified in a number of ways. At the Tbilisi Conference, these problems have been grouped as the following depending on different viewpoints:

1. nature of consequences - physical, economic and social consequences;

2. geographical scale - global, regional, national and local levels;

3. time-scale - short-term consequences and long-term consequences;

4. stage of development - social, economic and technological systems.

Since all these classifications deal with the same type of problems although with different angles, a detailed account of these problems will be given while discussing the first group.

4.1 Environmental problems having physical, social and economic consequences

Environmental problems having physical, economic and social consequences may be grouped under three categories:

(a) resource deterioration - problems arising from shortage of food, mineral, power and other resources, in the face of a rising global population of human beings;

(b) environmental pollution - pollution of air, water and land causing biospheric destruction including man;

(c) human health and quality of life;

(d) radioactivity from nuclear weapons and nuclear energy production.

Many of these problems have been caused by the human activities in the process of using the environment for various needs. The use of the environment is a necessary and acceptable concept. The difference is only in the way of use. Instead of the old pattern of use and discard, the future must be in the recycle context of perpetual renewal and re-use. A stable state between civilization and the environment is called for.

(a) Resource deterioration

This is a twofold process involving reduction in the quality as well as quantity of resources. The entire earth including the ocean and atmosphere, has raw materials that can be made useful if we can develop the necessary ingenuity and skill. Some of these resources such as timber, air, water and food are renewable, whereas others such as oil, gas and minerals are non-renewable. However, renewable resources are renewable only as long as environmental conditions are favourable for their natural or man-induced reproduction. Careless use of renewable resources may destroy them to an extent that they may not be available to mankind in the near future. The problem is much more with the finite resources, whose over-exploitation may cause deprivation of such resources in the future.

Problems of resource deterioration may be discussed under the following headings: soil, plant, wildlife, minerals, energy and water.

Soil resources: the soil is the very heart of the life layer on the land. It is a place in which plant nutrients are produced and held. It also holds water in storage for plants to use. Soil formation leading to a characteristic set of soil horizons requires a long span of time, a fact of great environmental importance. Man's activities such as agricultural, industrial, urban and others, can destroy in a short time a delicate soil profile that took centuries to form. Soil is a renewable resource in terms of agricultural production (Strahler, 1977). Once the natural soil is degraded or lost, the loss in terms of useful plant production is permanent. Soil thus forms one of the important life support systems of the world.

Global soil resources are limited both in quality as well as in quantity. Only about 30 per cent of all the available land on our planet is ideal for human habitation. FAO claims that only 32 million square kilometres of available land is potentially good for farming and the best of this is already under cultivation.

Slow removal of soil through denudation and erosion is a natural process, which is both inevitable and universal. Under stable natural conditions, this process is as slow as that of soil formation. As a result, there is a balance between the two processes and the soil is able to maintain itself. However, man's activities or rare natural events may accelerate the rate of soil loss. Deforestation, overgrazing, overcultivation, mining activities, construction of buildings, transport and communication lines and irrigation projects affect the soil layer in different ways causing soil loss. Destruction of vegetation cover and overgrazing cause widespread soil erosion. In the absence of plant roots which hold soil together, soil is left loose and is washed away easily by the wind and water. It accounts for major losses in productivity. Washed away soil is transported through wind and water and is deposited finally at the bottom of the sea. This is called sedimentation. Judson (1968) estimated the mass of material moved annually by all rivers to the ocean before man's intervention at 9.3 billion tonnes. The rate, after man's intervention, is given as 24 billion tonnes per annum. This suggests an increase in the erosion rate by about two and a half times. Some individual rivers like the Amazon, Ganges and Brahmaputra carry enormous amounts of sediments. Wind transports less material, although Sahara dust is an important factor for sediment deposition in the eastern Atlantic Ocean, where it accounts for movements of billions of tonnes of sediments annually (Morales, 1979).

Mining directly disturbs the land in many ways such as surface disturbance and disposal of water. The extent of the earth's surface disturbed by worldwide mining operations has not been measured accurately. However, with increasing world production of minerals, question of land use and land rehabilitation becomes increasingly important, since they can help in reducing the environmental damage. Some of the areas with thin soil cover and fragile ecosystems such as the Arctic regions, once disturbed in balance, are difficult to be restored. Mining activities in India have caused severe ecological and environmental hazards. Over 5,500 mines operating in the country (India) without adequate safety measures to protect the environment have caused environmental problems like landslides in the Himalayas and in other tectonically active regions, and soil erosion leading to destruction of watersheds, siltation and loss of valuable fertile soil in the plains (Rai, 1984).

The growth of settlements, transport and communication lines have taken over vast stretches of land, which otherwise would have been a living and regenerating part of the earth. It had been estimated that a million acres of living soil are blotted annually by the erection of man's buildings alone (Jackson, 1976). Similarly, roads, railways and airports are eating up vast land areas as they spread across landscapes. During 1972-1982, in developing countries alone, more than 30,000 km^2 of land were turned into settlements and roads. An estimated 30,000-70,000 km^2 of land was lost to food production in this way in the ancient times.

Excessive irrigation and poor drainage coverted much productive farmland into saline and alkaline deserts, and have especially affected the countries like Egypt, Iran, Pakistan, India and Bangladesh. The trend in Western irrigation systems is in the same direction. The problem is acute in semi-arid and arid regions. According to some estimates, between 30-80 per cent of all land under irrigation has been subject to salinization, alkalinization and waterlogging. Large areas of several countries such as the Syrian Arab Republic, Iraq, Jordan and Mexico are affected by salinization. Each year, 200,000-300,000 hectares of the world's best land are

affected by salinization and waterlogging (Eckholm, 1976; Worthington, 1977). The United Nations Conference on Desertification/UNCOD (1977) estimated that one-tenth of the area under irrigation is waterlogged (22 million ha.).

Productivity of some 60,000 km^2 of land is being destroyed or impaired annually due to desertification (Eckholm and Brown, 1977). Desertification results from the combined effect of two sets of factors: severe and recurrent drought and human over-exploitation of drylands. The Sahara is extending in the east as well as in the west. New areas are being desertified in countries such as Brazil, Morocco, Libyan Arab Jamahiriya and Pakistan (Holdgate, et al., 1982).

Pesticides are toxic chemicals which stay poisonous for long periods of time. Soil, once impregnated with them can remain seriously toxic for many years. Food crops when grown on this soil may continue to absorb the poisons which are then passed on to the human population.

Thus vast productive areas are being lost annually causing serious environmental concern, which needs immediate action at all levels.

Plant resources: plants are also consumable and renewable sources of food, medicines, fuel, clothing, shelter and a host of other life essentials. The present distribution of species of plants on land is the product of a long history of migration and evolution, influenced by climate and movement of the continents (Darlington, 1957; Good, 1974) and by human manipulation. Native plant cover in an area that attains development without appreciable interference by man and is subject to natural forces of modification and destruction, is called the natural vegetation. Some areas of natural vegetation are in a natural state because man has scarcely touched them. For example, rain forests of the wet equatorials, arctic tundra and the needle leaf forests of the subarctic zones. In contrast, much of the continental surface in mid-latitude is totally under man's control through agriculture, grazing or urbanization. Man has influenced vegetation to some parts by moving plant species from their indigenous habitats to foreign lands and foreign environments. The eucalyptus tree is a striking example. Various species of this tree have been exported from Australia - its native land - to be transplanted in far off places such as California, India and North Africa.

Forests represent the natural vegetation. It was estimated that by the mid-twentieth century, mankind has reduced the world's original forested area by at least 33 per cent (Sommer, 1976; Myers, 1979). On the steep slopes of the Himalayas and the Andes, tree felling and forest clearance has caused soil erosion, silting, flood and landslides. Forests are cleared for agriculture as well as for construction and fuel wood, which is still the dominant source of energy for cooking in most of the developing countries. Due to destruction of natural habitats, several species are threatened with elimination. According to the International Union for Conservation of Nature and Natural Resources (IUCN) 10 per cent of the species of flowering plants are under this category. Our dependence upon wild species of plants should not be underestimated. About 30 plant species provide our basic food stuffs. Others provide timber, paper, resin, fibres and medicines.

In the next few decades more species than ever before might become extinct as man disrupts the most complex biological community on the earth - the tropical rain forests. These cover less than 7 per cent of the earth's land surface but contain 30-50 per cent of all living species (Collins, 1984). Destruction of vegetation results in simplification of the ecosystem structure through elimination of plants which play an important role in the ecological food chain. Removal of forest cover may also lead to increase in certain insect populations which might pose health hazards e.g. tse-tse fly increase in the bush that takes over from forests.

Cultivation of crops represents modification of natural distribution of certain species of plants. However, man has not been able to control the whole ecosystem since natural processes of the biosphere, and especially climatic extremes like droughts and floods can still interfere with their production.

Farming practices and use of fertilizers and pesticides have affected the environment in several ways. Permanent cultivation has unfavourable ecological consequences. Shortening of fallow period does not allow nutrient replenishment in the soil and hence drop in the crop productivity. This loss is compensated through the application of chemical fertilizers supplying the plant nutrients (nitrogen, phosphorus and potassium). However, plants rarely use more than 50-60 per cent of the nitrogen in fertilizers. The residual nitrogen is liable to pollute ground and surface waters causing over-enrichment. In many developing countries, human excreta are traditionally used as a fertilizer. Without proper composting, this may, however, be a major cause of the spread of diseases.

Wildlife resources: like plants, several of the wildlife species are threatened with elimination. According to IUCN, 1,000 species of birds and mammals belong to this category. Outright attack upon wild animals is the most obvious way in which the wildlife is destroyed. Monkeys are snatched from the forests for a variety of medical purposes; whales are killed for their oil. Besides destruction of their natural habitats, water and air pollution by toxic chemicals are the major reasons for loss of species. For example, part of Lake Nakuru National Park in Africa, world-famous for its flamingoes, has been used for settlement and roads. Due to these activities, many species have been reduced in numbers e.g. brown bear, wolf and others in Europe and red wolf and black-footed ferret in North America.

The safeguarding of the flora and fauna is essential for maintaining ecological balance. Even insects, notorious as pests and carriers of disease, can be of value in controlling their own kind.

Mineral resources: mineral resources represent the physical heritage of our planet earth in the form of raw materials for construction and industry. It is found in or on the earth's crust as concentration of a naturally occurring solid, liquid or gaseous material, in such a form and amount that the economic extraction of a commodity from the concentration is currently or potentially feasible. In the formation of a mineral resource, matter has been concentrated by geologic processes over a very long period.

Minerals are usually grouped into two categories - metallic and non-metallic. Their extraction, processing and use have different impacts on the environment. Mineral extraction and processing have a wide range of environmental impacts which can be divided into four categories - impacts on land, atmosphere and water and socio-economic environment of people. Mining activity defaces the land with great sears and pits, destroys ecosystems, and brings on many undesirable side effects such as water pollution and the disturbance of hydrologic systems. Besides, human development and use of mineral resource cause redistribution or dissipation of these materials, not destruction; although patterns of use of partcular minerals may take their re-use unfeasible. Extraction of the most concentrated and accessible deposits are economical to exploit, but in future mining and processing of these resources may be expensive due to dispersion of these resources or availability of inferior quality ores. Moreover, geological processes operate so slowly that increased rate of consumption of these resources would not give sufficient time for their replenishment in the natural process. As such, for all practical purposes these resources may be termed non-renewable since their replenishment during man's life time on the earth is not possible.

Minerals play an important role in the international relations. The strategic aspects of mineral supplies, renewed concern over depletion, analysis of comprehensive materials cycles rather than separate mineral sectors, problems and prospects for recycling and substitution, investigation of long-term relationships between economic growth and the impact of energy and environmental costs form major issues of the international debate on the new international economic order. Some of the developing countries of the world, whose economy is entirely dependent on export of minerals, such as Zambia, have witnessed serious setbacks in their economies due to severe fluctuation in the price of those commodities in the world market.

Energy resource: along with other natural resources, the consumption of energy has taken the same sharp turn as the global population. Prodigious increase in energy/consumption poses many problems, including serious threats to the environment. Use of energy continues to rise at the rate of 4.5 per cent per year. World energy consumption rose by about 30 per cent between 1970-1978. About 80 per cent of this was in developed countries. Since most of our energy resources such as fossil fuels and atomic minerals are finite, we face the danger of confronting major energy crises. Besides, extraction and processing of fossil fuels, like minerals, is a potent cause of environmental disruption.

Water: fresh water is one of the necessities of life, but it is a scarce and hard-won commodity, because of the limited amount available. The volume of groundwater in storage is vastly greater than the volume of fresh water in rivers and lakes, which is less than 0.01 per cent of global waters. Besides, fresh water supply undergoes both seasonal and yearly fluctuations. They are also subject to man-made changes in their physical and biological qualities.

Of the three major uses of water i.e. domestic supplies, industry and agriculture, agriculture makes the major demand. Greater human activity tends to deplete locally available supplies. Continued growth of world population and acceleration in water use has started straining the water resources of some areas, even in humid regions. The strain was more acute by deterioration in water quality brought about by agricultural and industrial use and waste disposal.

Large numbers of people do not have access to safe, clean water and have no sanitary services. These shortages are more pronounced in rural areas. In 1970 only 14 per cent of people had access to safe water supplies, which rose to only 29 per cent in 1980.

Inland water systems have been particularly susceptible to invasion of some aquatic plants and animals, usually with undesirable effects. For example, water hyacinth, a native of South America, spread over 1,600 km on the Congo river in the early 1950s; entered the white Nile system of the Sudan in the late 1950s and continued to be a massive pest even in 1980. It was only partially controlled by expensive spraying of herbicides (Wolverton and McDonald, 1979).

(b) Environmental pollution

The existence of pollution in the environment, as a national and a world problem was not generally recognized until the 1960s. Today it is increasingly being appreciated that the general effects of pollution produce a deterioration of the quality of the environment which may be summarized as the following:

(i) damage to human health caused by specific chemical substances present in air, water and food;

(ii) damage to the natural environment which affects vegetation, animals, crops, soil and water;

(iii) damage to the aesthetic quality of the environment caused by smoke, noise, dumping of rubbish and waste;

(iv) damage caused by long-term pollution effects which are not immediately apparent, for example, effects of radioactivity (Dix, 1981).

The problem of pollution has increased in recent years because of many interrelated factors such as increased world population, increased food, energy and natural resources consumption, developing technology and economies.

Most pollution is caused by the need to dispose of waste, which cannot be completely eliminated. The wastes are gaseous, liquid or solid materials which are released into the atmosphere, or discharged into rivers or dumped on land respectively and thus pollute the environment.

Wastes are produced from eight broad sectors:

1. domestic sector producing wastes such as dustbin refuse, sewage, detergents, worn-out furniture and household equipment;

2. commercial and retail trade sector producing mostly solid wastes such as papers, plastics and boards;

3. manufacturing sector - these provide a variety of wastes and pollutants.

4. mining sector;

5. construction industry sector;

6. agricultural sector;

7. food processing industry sector;

8. nuclear energy and power sector.

Besides wastes, chemicals such as pesticides, fertilizers, drugs and food additives also pollute the environment.

Problems of environmental pollution may be discussed under three heads - land, air and water. While discussing resource deterioration we concentrated mostly on the depletion of various resources, that is in quantity. Here, emphasis is more on the quality of the environment.

Land pollution: solid wastes dumped on land pose a serious environmental problem. These wastes come from different sources such as residential premises, commercial premises, and industrial sites and premises. In respect of environmental pollution, the quantity, the treatment and disposal methods of waste are very important. A wide range of so-called 'disposable' goods made of paper and various kinds of plastic are very convenient for consumers but they aggravate the disposal problem. Plastics are not easily affected by bacteria or affected by weather.

Fertilizers and pesticides have been used by farmers, foresters and gardeners in all the developed countries for the last 30 years. Now the developing world is also using them to improve productivity. However, these chemicals constitute a very

serious aspect of land pollution, because substances such as DDT can enter the natural cycles and ecosystems and affect food, health and continued existence of animals and human beings. Moreover, land pollution does not exist in isolation. Various chemical pollutants can move from the soils into streams, rivers and the sea.

Water pollution: water pollution like other forms of pollution is caused basically by man's inability to dispose of waste in ways that do not change the natural balance of the environment. Large volumes of sewage effluent and industrial effluents discharged into rivers, lakes and seas cause water pollution. Waste chemical substances enter and accumulate in ecosystems and food chains. Biological life and human health can be affected and the quality of the environment becomes degraded. The Minamata disease is just one example of the impact of chemical pollution on man. A plastic manufacturer was releasing mercury-laden wastes into Minamata Bay. The mercury, in its toxic methyle form, was concentrated in the predatory fish through the food chain of the bay ecosystem. The fisherfolk who subsisted largely on fish were affected by mercury poisoning. By 1976, a total of nearly 900 victims of the poisoning were officially recognized (Strahler and Strahler, 1977).

Air pollution: present atmospheric pollution originated from three main sources:

(i) the combustion of fuels to produce energy for heating and power;

(ii) the exhaust emissions from transport vehicles using petrol, or diesel oil or kerosene fuels;

(iii) waste gases, dust and heat from many industrial sites.

Atmospheric pollution impacts on the biosphere in many ways. These effects may be broadly considered under three headings - the effect on buildings and materials, the effect upon the soil, vegetation crops and animals, and the effect on human beings. The fabric of buildings surrounded by heavily polluted air for years may undergo chemical changes. Metal surfaces are attacked by atmospheric pollutants and are corroded.

Gaseous pollutants in the air and deposition of particulates on to soil can affect plants. The precipitation of rain, containing dissolved SO_2, over a period of time tends to lower the soil pH and it becomes acid. In the Sacramento Valley in California, the combination of SO_2 and metallic pollutants killed all vegetation in an area of 260 km^2, and affected growth on a further 320 km^2 of land (Dix, 1981).

Farm cattle can also be affected by atmospheric pollution. Cattle grazing near aluminium plants and brick works have been known to show loss of appetite, low milk yield, lameness and joint stiffness.

The most widespread effects of air pollution on human beings are caused by smoke and SO_2. In London between 5 and 9 December 1952, heavy continuous smog conditions caused an estimated 4,000 deaths above the normal expectancy for December. The chief causes of death were bronchitis, pneumonia and associated respiratory complaints (Dix, 1981). Some other pollutants from specific industrial locations cause other kinds of diseases. Most of these pollutions are restricted to the troposphere. However, the use of supersonic transport aircraft in the future may cause pollution in the stratosphere also, which may raise the earth's temperature.

Many substances are potentially harmful for human health. Some of these are carbon monoxide, sulphur dioxide, ozone, nitrogen dioxide, lead and particulates including mineral dusts, fibres and a range of manufactured chemical compounds. Prolonged exposure to asbestos and glass fibres may cause cancer of the lung lining or abdomen.

(c) Human health and quality of life

Human health and quality of life are greatly influenced by the environment. Although environment as well as genetic factors are involved in the production of disease, the environmental determinants such as water supply, urban environment quality, climate and the pattern of human contacts are emphasized more.

In the world as a whole there are three broad groups of diseases that account for a large proportion of illness and death (Holdgate, et al., 1982):

(i) communicable diseases;

(ii) degenerative diseases;

(iii) neoplastic diseases (cancers).

Communicable diseases account for a large proportion of illness and deaths in developing countries. Environmental factors such as water, quality of the urban and residential environment (especially excretion disposal systems) and patterns of human movements and contacts play a major role in the transmission of communicable diseases. Of these, water is the most important factor. Water logging helps in breeding of mosquitoes which cause malaria, yellow fever and dengue and snails which cause schistosomiasis. Besides, it is the medium of transmission of cholera and diarrhoeal diseases.

Environmental variations are reflected in seasonal difference in the incidence of diseases in many parts of the world. Some communicable diseases are transmitted much more easily during the rainy season.

In developing countries, six major diseases accounted for the deaths of some five million children annually between 1972-1982. These were diptheria, whooping cough, tetanus, measles, poliomyelitis and tuberculosis (Holdgate, et al., 1982).

Malaria and schistosomiasis remain widespread diseases of the tropics. DDT spraying in the 1950s and the 1960s had dramatic effect in reducing malaria cases but during the 1970s there was a resurgence of the disease. Environmental and economic conditions contribute to the cause of the disease no doubt but an important factor has been insecticide resistance in the mosquito and drug resistance in the parasite.

Degenerative diseases such as those of the heart and circulatory system and neoplastic diseases (cancer) account for a significant proportion of illness and death in developed countries of the world.

A number of chemicals are harmful to human health and the rate of their circulation through the environment has been greatly increased by human activities. Several chemicals contribute to the development of heart diseases. Increased arsenic in soil and water enhances occurrence of cancer. Pollution of air, water, soil and food cause several diseases and these tend to be major health hazards.

Malnutrition has been a major underlying cause of death and illness in developing countries. In contrast, obesity and cardiovascular diseases have increased in the developed countries (Holdgate, et al., 1982).

Variations in life styles and cultural practices are related with certain kinds of diseases. For example, the unusually high incidence of oral cancer in India is related to the peoples' habit of chewing the betel nut. Obesity is a serious health problem of industrialized countries and affluent groups elsewhere.

Physical disruption: physical disruption mainly includes the effects of noise pollution. Noise can damage the ear and cause temporary or permanent noise-induced hearing loss, depending upon the intensity and duration of the sound level.

Noise can arise from various sources such as transport vehicles and industrial machines. Studies have shown that noise can be a major human irritant as it may affect mental health.

(d) Radioactivity from nuclear weapons and nuclear energy production

Nuclear technology has generated a worldwide debate on the environmental hazards embracing topics such as possible risks to people exposed to low levels of radiation, the safety of nuclear installations, the impact on particular sites, environmental risks associated with radioactive wastes and diversion of nuclear material for non-peaceful purposes. Of these topics, the last one is of great significance since the raw materials and technology needed for the production of fissionable materials that could be used for either nuclear weapons or power generation are the same. Even if the purpose is peaceful the question arises whether there are short-term or long-term dangers from the radioactivity involved.

Radiation emanates from both natural and man-made sources. The entire global population receives background radiation from three natural sources in the environment. These are cosmic rays from outer space; the earth's crust containing nuclides in rocks, soil and natural building materials; and the human body. However, there is no real evidence to show harmful effects of the average natural background radiation. Man-made radiation sources are X-rays, atmospheric fall-out produced by the explosive tests of nuclear weapons and industrial emissions mainly from nuclear reactors and processing installations. The effect of X-ray exposure is cumulative in the body and, therefore, the total dosage received by any indivdual should be carefully recorded. As regards atmospheric fall-out radiation there has been a Nuclear Test Ban Treaty, whereby agreement has been signed by nuclear powers to use only underground tests having little or no fall-out. Operations of nuclear reactors and the complementary nuclear fuel processing contribute to environmental radiation. However, some studies have reported that likelihood of a major reactor accident is small, although public perception of the risk of such accidents is very much greater (Slovic et al., 1979).

Health hazards from ionizing radiation at all stages of nuclear energy production have been reported from time to time. Miners of pitchblende (an ore of uranium and radium) in Germany and Czechoslovakia were the first groups to show the effects of ionizing radiation since 50 per cent of these miners died of lung cancer attributable to radiation exposure (Strahler and Strahler, 1977).

4.2 Environmental problems on geographical scale

All environmental problems have a space dimension since some of them may be localized at village, city, state and country levels while others may be global in nature. Depending upon the areal extent, they may be grouped under local, national, regional and global levels.

Local level: problems of a particular village or a city may be considered a local problem. For example, congestion of buildings, waterlogging in low lying areas, improper drainage, lack of health facilities and poor sanitary conditions are some of the problems which may be considered local despite the fact that they may be common to all villages or cities of the country. They are considered local problems because their solutions are to be found locally and they need public participation in decision-making as well as in implementation.

National level: some of the environmental problems such as control of certain diseases; waterlogging and salinization due to irrigation projects and industrial pollutions require efforts at the national level. Several environmental problems may be averted if environmental factors are integrated into the process of planned economic development. For instance, specialized advice on environmental aspects could help in designing projects without having adverse effects on the environment. Similarly in pollution control, national policy and environmental laws may safeguard the unwanted impacts of development.

Regional level: environmental problems which do not restrict to the boundary of a nation but encompass a wider area covering more than one country require concerted efforts of all the nations involved. The spread of deserts and destruction of tropical rain forests are such examples which have affected several countries at a time.

As mentioned earlier in the module, the spread of the Sahara desert is a problem of regional magnitude. Approximately 650,000 km^2 of productive land in the southern portion of the Sahara alone is estimated to have become desert in the last 50 years. It has extended in Sudan, Ethiopia and Somalia in the east and in Senegal in the west. In Sudan, the desert is reported to have extended 90-100 km in 17 years prior to 1979 (Holdgate, et al., 1984).

Since desertification in this region has been caused mainly by the human overexploitation of dry lands through overgrazing, the solution lies in the biological recovery of environmental conditions. But corrective measures are expensive and the governments of all countries facing this problem, need to share the burden by including portions of these measures in their development plans.

Similar to the desertification problem, destruction of rain forests in the tropics is a regional problem concerning several countries. It is required that all countries facing the problem make a concerted effort to adopt corrective measures for which they could jointly prepare a plan of action.

Global level: the impact of man's activities on the global mechanisms of climate, exhaustion of fossil fuel resources, soil erosion, destruction of wildlife, nuclear proliferation and dangers of nuclear war are some of the environmental problems of a global nature. Many such problems arise at local or regional levels, but through pathways of air, water and soil, have spread to a wider area. Since these problems are widespread, they need co-operation among all nations to solve them.

4.3 Environmental problems on the time scale

Environmental problems may also be classified on the basis of the time span required to reveal effects i.e. immediate effects and long-term effects.

Immediate effects: those environmental problems which have produced a deterioration of the environment in a very short time would come under this category. For example, air pollution by smoke and SO_2 has general and widespread effects on

people. Similarly, waterlogging and poor sanitary conditions leading to the spread of diseases like malaria, schistomsomiasis and typhoid have a wide effect.

Long-term effects: certain kinds of environmental problems would reflect their impact only in the long run, for example, atmospheric pollution leading to slow climatic changes or impacts of radioactivity from disposal of nuclear wastes.

4.4 Environmental problems of the developed and developing countries

Stages of social, economic and technological advancements also determine the nature of environmental problems. Due to high industrial and technological development and economic prosperity, developed countries of the world are facing environmental problems of industrial pollution, fast depletion of mineral and energy resources and diseases like obesity, cardiovascular ailments, cancer, alcoholism and drug addiction. On the contrary, developing countries of the world are confronting problems of overpopulation, squalid housing, lack of sanitation and clean drinking water, deforestation and communicable diseases. Limited financial resources, shortage of skilled people and appropriate technology retarding development efforts in the Third World, have accelerated the environmental constraints.

However, environmental consensus should not be a barrier to development anywhere. In fact, all countries need to undergo further development. The only thing to keep in view is that environmental concerns should be a part of the developmental process so as to make it ensuring and free from unwelcome side effects. The Stockholm Conference came out with 'ecodevelopment' as a central theme, which described the process of ecologically sound development. This meant a process of positive management of the environment for human benefit.

4.5 Solution of environmental problems

The situations we now recognize as environmental problems have often developed over the years as a result of new scientific and/or technological innovations. Initially, many of them were thought of as being beneficial with few or no perceived disadvantages. Years after, environmental implications came to be recognized, by which time the whole issue is considerably complex because of many social, economic and political factors.

It is, therefore, important for sensible participation in the resolution of environmental problems, to be able to identify the environmental components involved and to view them from different angles. For example, the building of a dam for irrigation and electricity is initially seen as most desirable. But it can also create several hazards which are significant but not known in the beginning. The reality of these hazards are highlighted only after several years when the damage is done. Besides, corrective measures incur further expenditure while financial resources are already limited. In India, Koynanagar (450 km south-east of Bombay) experienced a devastating earthquake on 10 December 1967. This region had been a non-seismic zone, but had experienced a series of tremors after impounding of water in the Koyna dam reservoir in 1962. In the earthquake of 1967, nearly 200 lives were lost, 1,500 people were injured and thousands were rendered homeless. More than 80 per cent of the houses were also rocked (Agarwal, et al., 1982). Although the Koyna dam moved in the earthquake, the huge structure did not collapse. Now the solution of the problem at this stage is difficult since the whole issue is considerably complex involving various factors. Hence, these need attention of the government machinery. However, public consciousness and involvement may help solve many such problems especially when that concern is reflected at the decision-making stage itself. The success of the environmental programme depends on the overall response to environmental concerns especially in terms of people's perception (Pal,

1982). It is crucial how people perceive and respond to the environmental problems. That will help them find solutions. Public participation and involvement comes through awareness and change in the value system. It is through proper education that we can learn about the environment and its problems and develop a proper attitude and responsible behaviour towards our natural environment. The time is now at hand when we must stop exploiting nature for our unsatisfying appetites and start living with nature by returning to it the materials we use by keeping our population in check and by following the ways of nature. The most practical solutions to our environmental problems are those which involve recycling, using alternative sources of energy such as solar and wind energy and significantly reducing all kinds of pollution in our ecosystems. Instead of going into the detailed account of means and ways of solution to each and every kind of environmental problem, it would be proper at this stage to expose the pre-service social studies teachers and supervisors to the various stages involved in the identification, and solution of an environmental problem. This would help them acquire certain skills in introducing an environmental emphasis into their social studies teaching.

Unit I: Identifying an environmental problem(1)

Objectives

(1) To develop students' understanding of what are environmental problems.

(2) To help students in selecting environmental problems for inclusion in social studies teaching.

(3) To develop commitment to an environment problem.

Suggested approach

Step 1:	Student-centred	or	Teacher-centred
	Few days before the commencement of this unit, teacher-educator will ask the pre-service social science teachers to collect newspaper items related with local environmental issues having some social input.		Teacher-educator prepares a list of local environmental issues and presents it in the class.

(1) Adapted from Fensham, P.J. and Hunwick, D.J., 1983. EE: Module for Pre-Service Training of Science Teachers and Supervisors for Secondary Schools, Unesco/UNEP International Environmental Education Programmes.

Step 2: The pre-service teachers are asked to group the news items in the following format:

1	2	3	4	5	6
List of environmental news items	Concerned subject areas	Problems associated with the news items	Subject areas involved in the problem	Environmental category	Problem re-stated as environmental problems
(a) Petrochemical complex at Mathura	Chemistry, engineering, geography, economics	(1) Increase in air pollution (2) Impact on the surrounding plant, animal and human population (3) Threat to the marble of the Taj - a historical monument	Chemistry, biology, geography, economics and history	Pollution	(1) Can we check the air pollution? (2) Can we reduce the damage to the biosphere? (3) Can we save the Taj - a monument from being destroyed?
(b) A major revolt against the state administration. Hundreds of tribals arrested in 'tree war' in Bihar	Biology, geography, economics, sociology, political science	(1) Government's policy on commercialization of forests leading to replacement of sal trees by teak	Biology, economics, political science, geography	Resource and population	(1) Is it necessary to replace the native sal tree by teak? (2) How can we commercialize forests without disturbing the natural habitats?

1	2	3	4	5	6
List of environmental news items	Concerned subject areas	Problems associated with the news items	Subject areas involved in the problem	Environmental category	Problem re-stated as environmental problems
		(2) Teak is of no value to local tribals and animals like elephants who survive on sal trees	Biology, economics, sociology, geography		
(c) Heavy monsoon rains, waterlogging in several areas	Biology and geography	(1) Poor drainage causing waterlogging	Engineering, civics	Pollution and disease	(1) Can we prevent waterlogging and spread of malaria?
		(2) Continued waterlogging would help in breeding of mosquitoes and danger of spreading diseases like malaria	Biology, geography, civics		

Step 3: To select a suitable environment problem for study and action by the whole class, students may be asked to give their priorities for the problems enlisted earlier on the basis of the following criteria.

(1) Is the problem significant? Yes/No

(2) Can this problem be related to the social science topics? Yes/No

(3) Can you get information (people, book) easily? Yes/No

(4) Is the problem relevant to you as a pre-service teacher? Yes/No

(5) Does the problem interest you? Yes/No

Step 4: Tabulate the scores for the class in the following manner: for every 'yes' answer, one mark may be allocated. Thus maximum score for each problem would be five. Add total scores for each problem and mark them. The problem having the highest score should be selected for study. In case two problems have the same rank, class discussion might help select one.

Unit II: Investigation into environmental problem

Introduction

An environmental problem is usually complex especially because of the complexity of social structures within which it occurs. It is always better to select strategies before starting investigation into the actual problem. There are three strategies which might be adopted to complete the task successfully.

(a) Training to ask specific questions for the desired information.

(b) To identify the known and potential source of answer to questions that have been formulated (libraries, people, institutions, government offices).

(c) Work in small groups.

Objectives

(1) To help students identify relevant sources of information.

(2) To promote a team approach to the investigation of problems.

(3) To help students develop greater appreciation of the relationships of nature and society.

Suggested approach

Step 1: In small groups of approximately four to five people, students should produce a list of questions for the required information concerning the environmental problem being investigated.

Step 2: Classify the questions on the basis of broad categories such as science, economic, historical, geographical, political and aesthetic.

Step 3: For each set of questions, identify the probable sources which would provide basic concepts, nature and magnitude of the problem. As such indirect (books, reports) as well as direct (visiting the area, interviewing the people/habitants of the area, various authorities, experts) sources have to be tapped.

Step 4: Gather information from different sources in groups to save time. Teacher-educators should review the work regularly.

Step 5: Processing of information and report preparation should be done on the basis of available data. It should contain different aspects of the environmental issue such as nature of the problem, the social context in which it occurred and its effects.

Unit III: Possible solutions

Introduction

Because of the complexity of environmental problems, it is possible that much of the gathered information about a problem may not be directly relevant to proposing solutions to it. However, pre-service teachers would be in a better position to judge these issues themselves and to appreciate that some of the proposed solutions are not feasible, some are inappropriate, and some are possible.

Objectives

(1) To assist students appreciate the numerous possible ways of dealing with the environmental problems.

(2) To help students understand the possible ramification of any proposed solution to an environmental problem.

(3) To develop students' appreciation of the individual differences in perceiving the consequences of any proposed solution to an environmental problem.

Suggested approach

Step 1: The teacher-educator should present a brief report of the investigation conducted by the class containing a range of information relating to the environmental problem.

Step 2: The pre-service teachers are placed into small groups. They are asked to discuss all possible solutions which they might think proper. During a set period of time (10-15 minutes), all suggestions are recorded.

Step 3: The small groups report to the whole class their suggested solutions and a master list of proposed solutions are made on the blackboard.

Step 4: The teacher then explains the consequences of implementing various solutions by giving examples. The class is then asked to infer the consequences for each possible solution assuming it was actually implemented. All inferences are recorded on a separate sheet in a tabular form as that of the master table.

Master table of proposed solutions
Environmental problem

Proposed solutions	Consequences				
	Ecological	Economic	Social	Political	Other
1.					
2.					
3.					
4.					

Step 5: On completion of table for the proposed solution, the teacher-educator asks each pre-service teacher to rate each of the consequences for the proposed solution on a 5-point scale.

(1) Positively desirable.

(2) Mildly desirable.

(3) Insignificant consequences.

(4) Mildly undesirable.

(5) Positively undesirable.

Step 6: When the consequences of most of the proposed solutions are ready, a class summary can be produced on the blackboard. The class can now discuss (a) the differences in rating that occurred from the same consequences for a proposed solution; and (b) which solution seems to be most desirable ecologically, socially and economically. If there are differences, which solution is to be preferred?

Step 7: Following the class discussion, final reports can be prepared giving arguments in support of one or more of their preferred solutions. This report can be presented before a wider audience comprising of other students, teacher-educators and some guest experts. After the report presentation, guest experts may be asked to evaluate the proposals and give his/her comments.

Unit IV: Possible strategies for social action

Resolution of many environmental problems depends on scientific research. Nevertheless, its implementation depends on the decision-makers and those members of the society who are affected by the problem. Social strategies are, therefore, significant since they can draw the attention of all politicians, administrators, experts and the public. Involvement in this sort of social action promotes the development of a sense of participation in the decision-making processes and hence in social change.

Objectives

(1) To assist students in getting themselves prepared for their involvement in environmental problems.

(2) To help students identifying a range of social actions.

(3) To develop awareness of the potential difficulties associated with social action.

(4) To help students select appropriate forms of social action in relation to a particular problem.

Suggested approach

Step 1: The teacher-educator presents a summary of the nature of environmental problems and stresses the significance of social action.

Step 2: Each student is given a list of possible social actions and a card on which an environmental problem and a proposed solution is outlined. The teacher-educator asks them to list for each proposed solution, as many different forms of social action as they consider appropriate. If they want they can add any other form of social action also which is not enlisted.

Step 3: Discuss different forms of social action for each proposed solution and choose appropriate forms of social action. In group work selected social actions should be marked according to cost, effectiveness, time required for implementation, personal appeal, and suitability for pre-service social studies teachers and secondary-school students.

Step 4: Croups can compare their rank ordering of forms of social action and discuss the differences that arise.

Step 5: If the class can pursue a particular environmental problem, they could select and undertake the appropriate form of social action. Otherwise, they can debate the appropriate social actions on the part of the school students that should be encouraged by the teacher and the school in association with their study of environmental issues.

At the end of all these activities, pre-service teachers will have acquired some degree of the skills that are involved in environmental education. One way to evaluate these skills and their commitment as environmental educators is to challenge them to undertake the social action of mounting a public display at school or college premises. A variety of presentation methods including photographs, charts, models and audio-visual techniques may be used. Pre-service teachers may be present

during the period of display to answer the questions of visitors. Evaluation of the success of the display could be done by a combination of assessments including:

(a) the standard of the various aspects of the display;

(b) the ability shown by pre-service teachers in answering the visitors' questions; and

(c) the comments from the visitors themselves in a fairly simple questionnaire, related with information, accuracy, presentation, possible solution and social action.

CHAPTER 5

TEACHING METHODOLOGIES

5.1 Introduction

Teaching methodologies to be responsive to the needs of a particular discipline should take into account the nature of the discipline itself, type and level of teaching objectives, learner characteristics, psychology of learning and teaching processes, and the resources available. The ultimate criteria of effectiveness of teaching methodologies refers to the extent of success in realizing the stipulated objectives. It is now an established fact that the same objectives can be achieved through more than one teaching methodology - obviously, teaching methodologies preclude prescription. The teaching methodologies included in this section are, therefore, suggestive. It is the teaching situation and ingenuity of the teacher which determines selection of specific teaching methodology at a particular point of instructional time. The teaching methodologies presented here imply that they have been found useful by practising teachers and/or they have research support for reaching the objectives of environmental education curriculum.

This section of the module has been divided in subsections. The first section briefly outlines determinants of the teaching methodology. It is followed by subsections on specific teaching methodologies - investigatory, clarifying strategies, simulated exercises and role playing, centres of interest, case-study, etc.

For completing this section of the module, it is expected that the teachers already know the goals of environmental education, its developmental perspective, its essential content, allied problems and issues, interdisciplinary and multidisciplinary approaches to environmental education. It is also expected that the teachers using this material have acquired core teaching skills like questioning, reinforcement, explaining, illustrating with examples, stimulus variation, classroom management, organizing small group work, etc. The expectation is not ambitious as this constitutes a part of the pre-service and in-service teacher-education programmes. If the learner feels that he lacks one or more of these prerequisites, he may go back to the relevant sections of this module and other materials (Jangira, 1982, 1983).

5.2 Determinants of teaching methodology

Overview

Objectives

After completion of this subsection you are expected to:

1. list at least five determinants of teaching methodology in the context of environmental education;

2. write at least three guidelines for taking decisions regarding the selection of teaching methodologies for teaching environmental education in local specific situations.

Learning activity

1. Reading the study sheet 'Determinants of teaching methodology'.

2. Unesco: Strategies for developing environmental education curriculum; a discussion guide for Unesco training workshop on environmental education, Unesco, Paris, 1980.

3. Gagne, R.M. Conditions of learning, New York, Holt, Rinehart and Winston, 1977 (Chapters on types of learning, learning transfer and instructional design).

4. Travers, R.W.M. Essentials of learning, MacMillan, New York, 1963 (Chapter on transfer of learning).

5. Bloom, B.S. Human characteristics and school learning, McGraw Hill & Co., 1976 (Chapters I, II and III).

Evaluation

You will evaluate your performance by answering questions after the completion of the learning activities.

Study sheet - Determinants of teaching methodology

The need for selecting appropriate teaching methodology for realizing specific objectives cannot be overemphasized. The selection of appropriate teaching methodologies in itself is a major contributory factor in learning. The decision is influenced by several factors like curriculum area characteristics, instructional objectives, learning psychology and instructional resources. The factors are considered as determinants of teaching methodologies. This section provides an overview of the determinants.

Curriculum area characteristics

The methodologies of teaching need to be matched to the specific needs of the curriculum area. It may be recalled that environmental education has a specific characteristic of its own emerging from the curriculum approach. Environmental education has been considered not merely a curriculum area but as a way of life which implies that its objectives go beyond mere knowledge and understanding to the action proper. Environmental education related values constitute essential input without which the action is either conspicuously missing or it is in an undesirable direction. It may further be recalled that the infusion model of curriculum development is followed. The model envisages that the environmental approach will permeate all curriculum areas.

In this module special emphasis is on social science subjects. Another factor relating to the area having implications for the selection of teaching methodology refers to remoteness of the environment in time and space. For example, in history the environment is remote in time. In geography, it can be remote in space. For the selection of teaching strategies these curriculum area characteristics will have to be taken into consideration.

Instructional objectives

Instructional objectives are specific performances the learner produces after his encounter with the instructional procedures in a teaching episode or a series

of them in a lesson or a unit. The instructional objectives are derived from educational objectives envisaged for the curriculum area. Considering the approach and focus of environmental education curriculum, the following four levels of objectives have been envisaged in the Unesco document indicated at (2) in overview:

1. ecological foundation level;

2. conceptual awareness level (issues and values);

3. investigation and evaluation level;

4. environmental action level (skill).

The teaching procedures need to be matched to instructional objectives in different areas. The effectiveness of instruction is determined by the fitness of the objective methodology match. For example, if an instructional objective is related to an environment-related issue, a discussion, a probe-based inquiry, a problem-solving approach might be useful. For re-creating the remote environment, simulation may be helpful. For values, clarifying strategies may be appropriate. For foundational level-based information expository approaches may be suitable. Thus, instructional objectives play a vital role in making decisions about the teaching methodology to be used.

Learner characteristics

Teaching methodologies need to be matched to the cognitive styles of the learners. Developmental characteristics of the learners also influence selection of teaching methodologies. The children at the secondary stage tend to desire independence to explore new things and new relationships. They develop critical capabilities. They question, rationalize and adopt. They do not take things without question. They tend to build up a moral code of their own against which they judge others. They acquire the ability to manage conflicts. The teaching methodologies responsive to a variety of these needs have to be used. Interactive strategies, discussion, clarifying approaches, investigatory projects will have to be pressed into service (Joyce, 1980).

Learning psychology

As pointed out earlier, the major purposes of environmental education is to develop environmentally literate citizens who have not only to acquire the necessary knowledge, cognitive skills and attitudes in the classroom, but these need to be transferred to the decision-making process of the receiver throughout life. The psychology of learning and learning transfer provide a number of guidelines and generalizations for use by the teacher towards realization of the instructional objectives emerging from this goal. The transfer of knowledge and skills is most likely when:

learners acquire experience with a variety of problems. Exposure to a wide range of problems helps to develop the much needed expectancy that each problem will have to be tackled in some different way;

learners learn to apply principles in situations with distracting and irrelevant elements. This is helpful in learning transfer as they develop the ability to discriminate between relevant and irrelevant features of problem situations and thus the relevant principles are identified and applied effectively;

opportunities are provided for the learners to learn and use knowledge in a variety of situations, since it has been demonstrated through research that the acquired knowledge tends to be most used in the situation in which it is acquired;

if transfer is the instructional objective, the teachers must teach for transfer.

For details refer to books 3 to 5 on page 60.

Instructional resources

The selection of methods of teaching is also governed by the availability of instructional resources. This appears to be more of a constraint than a determinant of teaching methodologies. But it has been included in the list of determinants since the induction of educational technology, self-instructional materials and individualization of instruction has made this factor reasonably weighty in the selection of teaching methodologies. For example, a multimedia approach can be adopted only if the necessary audio-visual equipment is available. Self-learning approaches can be adopted if the necessary instructional materials are ensured. In the absence of adequate transport systems, planning of 'beyond the school wall experiences' may be quite difficult. In this way, this factor assumes vital significance.

Organizational support

The selection of teaching methodology also depends on the context of the classroom and institutional organization. Some methods can be used only if scheduling is flexibile with provision for teachers to experiment and innovate with the teaching methodologies. This is all the more important in environmental education curriculum transaction. Team teaching requires support from the principal and colleagues. The organizational support from the institution and its members is quite necessary for the effective use of these methodologies. Sometimes even community support is needed. For example, some parents object to their wards for out-of-school wall experiences. Simulation, gaming and problem-solving require flexible scheduling. Thus organizational support facilitates the use of specific methodologies of teaching in situ.

5.3 TM-I Investigatory approach: scientific inquiry training strategy

Overview

Objectives

After reading the study sheet you are expected to realize the following objectives:

1. list goals of inquiry training;
2. list rules of procedures for scientific inquiry training;
3. describe the phases of scientific inquiry training;
4. describe teacher role in scientific inquiry training;

5. take up an environmental education problem and plan a lesson following scientific inquiry training strategy;

6. describe how scientific inquiry training can be used in problem-solving.

Learning activity

1. Reading study guide sheet 'Investigatory approach: scientific inquiry training strategy'.

2. Reading the following or similar references:

   (i) Marsha Weil and Bruce Joyce, Information processing models of teaching, Prentice Hall, Inc., Englewood, New Jersery, 1978;

   (ii) Eagen Paul, Donald, Kanchae and Robert J. Harder, Strategies for teachers: information processing model in the classroom, Prentice Hall, Inc., Englewood, New Jersey, 1979 (Chapter 8);

   (iii) N.K. Jangira, Education for peace, international understanding, co-operation for development and human rights, Department of Teacher Education, NCERT, New Delhi, 1984 (pp. 30-32).

Evaluation

After completion of the unit you will be required to answer questions given at the end.

Study sheet: Investigatory approach: scientific inquiry training strategy

Problem-solving following investigatory approach is helpful in collecting information and processing it according to requirements of the problem at hand. It develops in the pupils the skills so necessary for taking decisions on different issues and taking positions for consequent citizenship action. Systematic inquiry training equips pupils with these skills. The training focuses on organizing knowledge with a view to explaining phenomenon under consideration and establishing cause-effect relationships.

The inquiry training involves five steps. Encounter with the problem is the stage wherein the problem or the puzzling event is presented and rules of procedures for the inquiry explained. This is followed by data gathering (verification) wherein pupils collect information to formulate hypotheses. Data gathering (experimentation) is the stage of testing hypotheses and establishing cause-effect relationships. This step is followed by formulating an explanation for the puzzling event. Finally, analysis of the inquiry process itself follows.

The case of 'missing islanders' was taken up for inquiry training in the classroom. The classroom transactions are presented to illustrate the application of the methodology to solve the riddle of missing islanders adapted from Weil and Joyce (1978).

Teaching encounter: The missing islanders

Phase 1: Encounter with the problem

T: We're going to do a strategy called inquiry training. That is, we'll try to figure out an event - a destructive event - something that we can't explain easily. You will ask me a series of questions to get information in order to try to verify what happened. I used the word 'verify'. Does anyone know what the word 'verify' means?

S: To prove?

T: Exactly, to prove to attempt to figure out what happened. Then we're going to try to develop theories about the event. What I'm going to do is tell you about the events. And then you've got to supply any further information by asking questions. I'll only answer 'yes' or 'no' to each of your questions. I'm going to tell you about the event now; then I'm going to explain the rules of our procedure.

In South America there is a very deep lake and it's fairly wide across. You could swim it, but it would be difficult. In the middle of the lake there is an island and surrounding the lake are several very rugged mountains which rise to about 11,000 feet. The lake is 6,500 feet above sea level (Figure 1).

Somehow the people dumped a lot of rocks into the water to make a causeway. These rocks make it possible to walk back and forth to the island.

The problem is, there's nobody there. The island is uninhabited. People left it about 300 years ago. Archaeologists with other methods have used carbon-14 dating in order to find out what had happened. These little things that you see here are representative of several houses made out of sandstone and limestone.

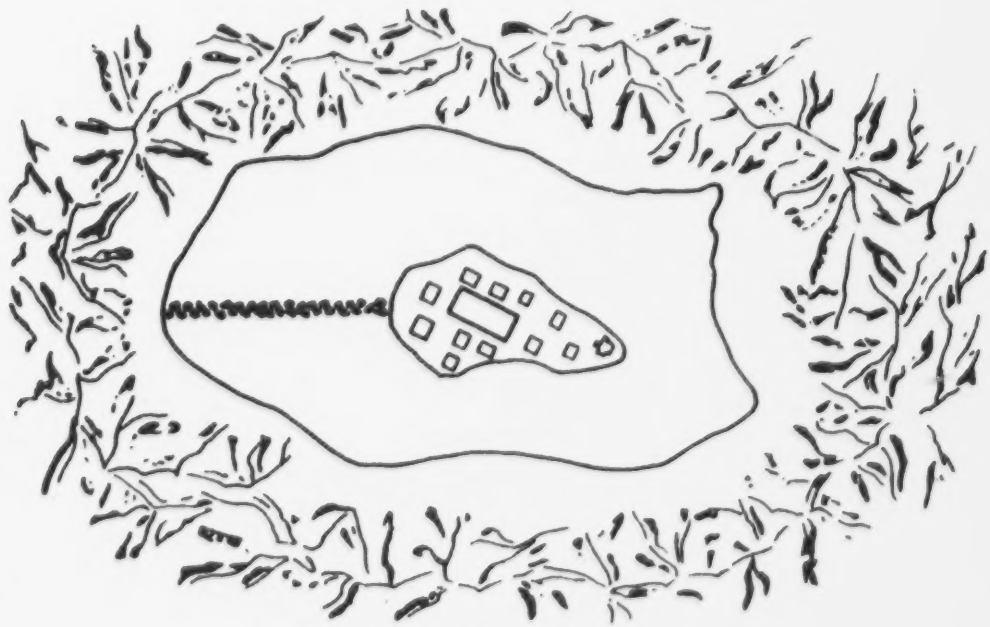


Figure 1

They also had very sophisticated cistern and street systems. As well as fairly sophisticated architecture. Except for the houses and the streets, every available space was used for producing crops and raising livestock and there is some evidence of fishing. In the middle of the island was a big marble square with several smaller levels on top of it. If you go to the very top of this marble edifice, you can sight the planets and stars, and actually see Venus at its winter solstice, which is 21 December; in other words, where it is at its lowest rise in the sky. Across the lake there are limestone quarries and a burial ground. Here the people have been buried with their hands folded. That's all the information that I'm going to give you right now. If I need to give you some more later on, I will. We know this happened about 300 years ago and we don't know why. We can only guess why, and we'd like you to help us try to figure out what happened.

Now the rules of our game. You may ask 'yes' or 'no' questions. If they're not 'yes' or 'no' questions or I can't answer them 'yes' or 'no' I'm going to ask you to rephrase them, because I can't answer them otherwise.

S: Do you know the answer?

T: We think we know the answer.

S: Oh, we're supposed to try to get it out of you.

T: Yeah. The point is that all scientific information is really tentative - we can only guess. And that's the case with this. Nobody really knows because it was 300 years ago. All we can do is put things together. That's your job. I think I have an answer. I want to see if you come up with the same one. Once you've asked a question, you can continue to ask as many questions as you want.

S: It's like what's my line?

T: It's a little bit like that. It's based upon the old game twenty questions. But we're going to be a little more sophisticated than that. One of the things that you can do is call for a conference and then you can talk among yourselves about the information that you are getting. I'll kind of pull out and you can work together to form your hypothesis. I won't mislead you intentionally. If a question can't be answered 'yes' or 'no', I'll tell you 'Yes', but that's going to be misleading, and I'll ask you to sharpen your question - O.K.? I won't mislead you purposely. Any time that you want to ask a theory question, I hope you'll do it, because all of our scientific evidence is going to be based upon the theories that we're going to form. Then we're going to test our theories. You can form a theory every time you want; but when you do, I want to make sure that you know that you've asked a theory question. If you're going to ask me a theory question, I won't answer you. You'll have to find out the answers for yourselves. Understand that rule?

Now what I want you to do is to gather data; in other words, I want you to ask questions in order to verify the events. For example, you can ask questions about the objects, such as the pieces of limestone. You can ask about the events that happened or ask about the conditions. These are data questions and I can answer these 'yes' or 'no' once you have formed a theory, we'll be asking you to experiment with 'if/then' sort of questions like, 'If something happened, then something else happened', but we'll get into those later. Who wants to ask me the first question in order to get more information?

Phase 2: Data gathering (verification)

S: Were they primitive?

T: You'll have to define what you mean.

S: Well, their material was not made out of steel or iron. I'm asking if they were primitive, and what I mean by that is, are the things that they used - were they like arrowheads - were they carved?

T: Are you asking me 'were there arrowheads?'?

S: Were there arrowheads?

T: Yes, there were. O.K., you want to go on?

S: There was?

T: Yes, not a lot, but some.

S: Could you get through the mountains?

T: You could get through the mountains. There were some passageways. But it was very difficult.

S: Well, may be some took a chance. Did they take a chance and go through these mountain passes?

T: They disappeared.

S: Was there any evidence of really bad or strange weather?

T: No evidence of that.

S: Other than the burial place, were there the remains of human bones?

T: Yes.

S: Just around in different places? Besides the burial grounds?

T: No, there was no other evidence. All of the human bones were in the burial ground.

S: Were there a lot of people in the burial ground?

T: No.

S: Were there any wild animals?

T: No.

S: Natural predators?

T: Not on the island.

S: Were there any personal belongings on the island, like people were living there?

S: Had they taken everything with them?

T: No, but I don't want to mislead you: most of the things that were left there were broken.

S: So it seems as if they left and took most the useable things with them?

T: Yes.

S: Were they the only people in that area? Was there anybody else around them?

T: You have to sharpen your question.

S: Was there anyone else in that particular place?

T: What do you mean by area? On the island?

S: On the island.

T: No, they were the only people on the island.

S: Were there people in mountains around the island?

T: What do you mean by the area?

S: Oh, a 100-mile radius?

T: No.

S: Were the majority of them women and children?

T: No.

S: Was there any evidence of disease?

T: You'll have to explain some.

S: When they did the carbon dating of the bones, did the archaeologists check for other things?

T: Yes, there was evidence of disease.

S: Do you know that disease was the cause of death?

T: Well, disease would have been a cause of death.

S: Was there evidence that there was a really widespread epidemic or something?

T: No.

S: Do you think that all the people that died were diseased?

T: No.

S: You did at first.

S: He was trying to trick me.

T: I don't want to mislead you; that's the point. But I want you to sharpen your question. Do you need more information?

S: Was there evidence of a drought? Was there evidence of irrigation?

T: There is some evidence of irrigation.

S: Did you say when you thought those people lived? Was it there a thousand years ago?

T: Three hundred.

S: Did you say how the rocks formed the causeway? Was it from a landslide?

T: No. They were dumped there.

S: The causeway was not man-made?

T: The causeway was man-made.

S: Do they know when the causeway was made, like from the erosion in the rocks?

T: No.

S: Three hundred years is when the Indians - American ...

T: It's in the mountains of South America and they're about 11,000 feet high.

S: Did someome come and take them away - from other parts of the country, people that were more modern than they might have been?

T: I can't answer that question. What is it?

S: Did someone from another part of the world who had modern transportation come over the mountains and take the people away?

T: Is that a theory question?

S: I want a 'yes' or 'no'.

T: Are you trying to verify it?

S: It was 300 years ago. So what was modern then?

S: Some people had never heard of horses - I'm quite sure they didn't have horses - but in other parts of the world there were people who we know had more modern skills; they were more developed or came upon this island and went across the causeway and got the people off of it.

Phase 3: <u>First hypothesis</u>

T: I'm suggesting to you that that's a theory question, if you'd like to test it. You are suggesting that a group more modern than they came and took them off the island. Is that what you're suggesting?

S: Anyone who is living in a place where there are mountains is likely to be not quite as civilized or advanced. May be someone else was.

Phase 4: Data gathering (experimentation)

T: It's a good theory. That's fine. Now our job is to ask questions that explore that possibility. Remember that all evidence is tentative. There are two kinds of questions that you can ask to experiment with your theory. The first are exploration questions, in other words, you would say, 'would it make a difference if this happened?'. And I could answer that, 'yes' or 'no', or you can ask, 'would the same thing happen if ...?'. And I can answer that, 'yes' or 'no' or if you were testing a scientific theory, 'if I held it near a fire, would the same thing happen?'. In other words, I'm trying to find out what the variables are. Do you understand what we're getting at here? I'm going to focus on her theory until you give it up or go to another one. Remember, all knowledge is tentative O.K., her theory is that somebody has come and taken them away.

S: I heard a story once that a small group of Indians were living together and another group of people came over the mountain and took some of them away.

T: O.K., let's test it now. What evidence do you have to test your theory?

S: Did you say where the people had come from before they went to the island?

T: We don't know.

S: Did they get the limestone rocks from quarries?

T: Yes, in the mountains around them.

S: They dug out quarries. So they must have had some technology.

T: Yes.

S: Were they as advanced as people in the flatlands?

T: I don't think we have evidence that there were people in the flatlands.

S: Was there any evidence of those people who lived quite far away?

T: Yes, there were some people, quite a distance away.

S: Were the people on the island strange? Is that why they lived there, because they couldn't be with other people?

T: No.

S: They were the same race, then?

T: Yes, if you take race in its broadest sense.

S: So there wasn't anything the matter with them that would make it necessary for them to stay on the little island?

T: We have no evidence of that. You should explain what you mean by 'something wrong with them'.

S: Well, were they crazy?

T: No, there's no evidence of that.

S: Did you say something about when they left, that everything was broken?

T: What I said was that the only things that were left were things that were broken.

S: Was there evidence of a fight?

(Evidence doesn't support hypothesis.)

T: No. But remember we're still on her theory. Let's focus. Do you want to drop the theory and go on to another one?

S: No, because it's the only possible reason, unless they all died off.

S: The things that were left were broken or probably things that were not necessary to take along, if they were going on a long journey.

T: What's your question?

S: Was there evidence of children?

T: Yes.

S: Well, maybe these people did decide that there were other parts of the world they wanted to see.

T: Why don't you get some questions? You've got some good points. Let's find out if they're true or not.

S: Do you know what kinds of animals were there?

T: Domestic.

S: Cows?

T: Yes.

S: Were there remains of horses, burros, donkeys or something like that?

T: I don't know if there were horses or not. There were some burrows, yes.

S: Were there remains of animal bones on the island?

T: Yes, some.

S: All domestic?

T: Generally, yes.

S: Did you tell us what's on this side?

T: Mountains. There is a treacherous pathway to the left. The burial ground and the stone quarries are in these mountains.

S: How long was the causeway? Did you say that?

T: About half a mile.

S: Are the rocks still there?

T: Yes.

S: Were there remains of bones around the lake?

T: Some, but nothing out of the ordinary.

S: What is the ordinary?

T: Nothing that would indicate foul play.

S: What was the grade on the causeway? How was it, flat? How far apart were the rocks and things?

T: It was easy to drive a cart across it.

S: You could walk?

T: They could have used the animals and travelled.

S: It seems as if they had left?

T: Yes.

S: Was there any evidence of travel?

T: Yes, they left. Now you've got to figure out why they left.

S: Was there an earthquake?

T: No evidence of an earthquake.

S: Was there evidence of overpopulation on the island?

T: We've got a lot of stuff now. You might want to get it together and formulate a theory.

S: Well, maybe when it snowed and rained, the level of the lake rose and the people thought that they had to split.

T: O.K., your theory is that the lake rose. How can we explore that?

S: If the lake rose, wouldn't the causeway have been submerged?

T: It was the same height as the island.

S: Were the broken parts that you found mostly in the middle of the island?

T: No.

S: They were at the edges too?

T: Yes.

S: So like it couldn't be that the water came over the island?

T: There's no evidence of that.

S: Was there evidence of furniture in the lake?

T: No.

S: Do you know how long they were living there?

T: I can't answer that question.

S: Why?

T: Because it's not a 'yes' or 'no' question.

S: Do you know?

T: We know that they left about 300 years ago.

S: So they must have lived there a long time. It was a small civilization.

S: Look at all the rocks that they moved.

S: I'm sure they were smart people there. Could they have figured out that the water was rising? And they said in so many years the water is going to rise.

T: So ask me a question to get at that, an if-then question. That's what you need to do. You need to explore and experiment now.

S: If the water had risen, then would the island have gone under?

T: No.

S: Would the rocks cave in or something? Was it solid?

T: There is no evidence of it caving in.

S: Is there any evidence of any religion they had, like they worshipped a certain god?

T: Yes.

S: What god?

S: Is it something that we've heard of before? Did they worship that we've heard a lot of people worshipping?

T: Yes.

S: Was it Christian?

T: Not that we know of, there was no evidence of Christianity.

S: Was there evidence of floating material like grass boats?

T: No, we're on his theory-focus.

S: What was it again?

T: Water rising.

S: With the water rising, couldn't they have made rafts?

(Evidence doesn't support hypothesis.)

T: No evidence of it. Bobby, do you want to give up on your theory and go on to another one?

S: Was there any evidence of extraterrestrial life?

T: There's no evidence of life from another planet.

S: Were there any calendars on the island?

T: Yes, I should tell you that there were calendars, but not like the ones we hang on the wall.

S: Were the calendars like those at Easter Island?

T: You have to tell me what Easter Island is.

S: All those rocks lined up in a certain way.

T: What did I say in the beginning?

S: You said that they had two rocks that lined up with Venus.

T: Right, yes.

S: Was Venus their god?

T: We don't know that. We know that Venus can be seen on 21 December.

S: Could that have been - if there were other people living around those people, put them on a boat, put them on the island, and come back. They were like prisoners. So they got all those rocks and put them in the water so that they could get off. So would it be like a prison?

T: You're theorizing you have a couple of theories there and I'm not sure that you've asked an information question. Is there any evidence of it being a gaol? Is that your question?

S: Yes.

T: No.

S: Is there any evidence of them being driven off?

T: No.

S: Did they leave any writing behind?

T: No.

S: For all practical purposes, they just left of their own free will?

T: As far as we know yes.

S: You said they did irrigate, but you didn't say whether there'd been a drought or something, or whether their irrigation system hadn't worked.

T: There's no evidence that water failed.

S: How about a famine?

T: You'll have to explain yourself.

S: Were they in need of food, so they left?

T: Is that a theory question? State it in the form of a theory.

S: If something had gone wrong with the plants - the plants died - so they decided to go some place else. They took what animals they could, but they couldn't get them all.

T: So give me a theory.

S: My theory is they were running out of food and they all decided to leave. A few stayed behind, but they left because of lack of food.

T: Fine, that's our theory. We're going to focus on that. What evidence do we have that will prove or disprove that. Ask your 'if-then' questions. Bobby?

S: If they ran out of food, could they have eaten their cattle?

T: Yes, they could have.

S: If they ran out of food and then ran out of cattle, could they have started eating each other?

T: There's no evidence of cannibalism.

S: Is there any evidence that the supply of fish in the lake was going down?

T: No.

S: There wasn't a lot of stuff on the island like there was on the mountain. There were more trees and things that they could eat. Berries ...

T: To answer your question, 'Did it make a difference where they were?' the answer is, 'Yes, it did'.

S: Was it just a natural difference? Things grew on the island, but different things grew in the mountains. Because they didn't have the seeds.

T: Yes, I think so.

S: Was there any evidence of the vegetation dying?

T: Yes, there was.

S: It was dying at a faster rate than what we consider normal?

T: Yes.

S: Do they have a reason for it dying?

T: I think I know it.

S: Because of blight - a disease of the vegetation.

T: You have to define disease.

S: Like bugs?

T: Bugs, no.

S: Any kind of bacteria?

T: What do you mean by bacteria?

S: Did the soil have a disease?

T: There is some evidence of that.

S: Was it hard to grow things on that island?

T: Yes.

S: Was very much sun hitting the island?

T: Yes, a lot of sun.

S: It was something in the soil, then?

T: Yes.

S: Was it the soil - the minerals? The soil was worn out, from reuse, being used over and over again?

T: Yes.

S: So there was lack of mineral content in the soil. Not enough of the minerals the plants need, like nitrogen.

T: Yes. O.K., you got it. Now one more quick one I want you to figure out, if you can. You talked a little bit ago about why they left. But now I want you to go back. You've got the evidence already - about how the decision was made to leave.

S: Did that sighting of the two rocks with Venus have anything to do with it?

T: Yes.

S: They were very superstitious, weren't they?

T: What do you mean?

S: Venus, we all know, isn't a god, it's just a planet. And so perhaps they worshipped it as a god. It told them to leave ...

S: Some type of omen.

S: Yeah, so I'm asking, did Venus have something to do with it?

T: You're theorizing that Venus had something to do with it, and it was some sort of omen?

S: Yes.

T: O.K. - testable - that's testable. Good.

S: Like we use almanacs - in the farmer's almanac, they sight the moon and they can tell crop success and things like that.

S: Were they looking for something specific? Were they looking for relief? Was there supposedly something coming that they were looking for? That would have relieved them if it had come?

T: I don't know how to answer your question. Did something come - or would something come. I don't know. Were they looking for something?

S: Did they believe this?

T: Yes. That's a little bit misleading, but I don't think it's too much.

S: Were they told to leave?

T: Yes.

S: Well, their Venus told them.

T: Venus told them to leave? Only in the broadest sense?

S: Would it be possible for them to have a leader that would say he could talk to Venus? Did they have a main man?

T: Yes, there's some evidence of that.

S: Was there a throne or a palace of some kind - something that a kind ...

S: Were the rocks facing Venus?

S: Was there a palace on the island that looked like a place where a king might have lived?

T: Was there?

S: An observatory.

S: The centre.

T: Yes, the centre. The rocks that faced Venus are the ones in the middle.

S: And so the temple was there too?

S: Was there a meteorite?

T: No. there's no evidence of meteorites.

S: Is there evidence that there were farmers and agriculture?

T: Yes.

S: Were there fishermen?

T: Some, but you've kind of established that in your last theory that you demonstrated. We've moved on to another one. We're focusing on whether there was an omen decided by some - what was it?

S: Deity?

T: O.K., it sounds like you people have all the information you need. Sounds like you need a conference that I won't participate in.

S: O.K. Let's have a conference.

S: What do you think, gang?

S: I think it was starvation.

S: Yeah, that was one of the theories. Because all the minerals in the land were being used up. They had to split because the food was running out.

S: We know that already.

S: Somebody told them to leave.

S: That time would only come on 21 December.

S: The winter solstice is the shortest day of the year. They must have thought something was going to happen on the winter solstice.

T: O.K., ready? Got some questions you want to ask?

S: Do you know if the reason why they left had anything to do with the winter solstice?

T: Yes.

S: Was something supposed to happen on the 21st?

S: The sun went down or something?

S: An eclipse!

S: Venus crossed in front of the sun and eclipsed!

T: You're on the right track. That's not, in fact, what happened. You're really so close, I'm going to tell you what happened.

Phase 5: Formulating an explanation

T: Let me help you with this one. Approximately every 800 years there are crossing of Venus and several other planets. Now let's figure back 800 years. What happened about 1,600 years before this happened? Is anybody scientific enough to explain the Star of Bethlehem? What is the scientific explanation of the Star of Bethlehem?

S: There was a fluke. Something happened at that time.

T: What happened? Venus and what crossed? I can't remember which star, but that's what made it brighter than any other so 600 years later, what happened?

S: Same thing.

T: And what happened?

S: It was an omen.

T: Basically they considered it as an omen again, so they followed the Star. They went about 300 miles away, and interestingly enough, about 300 miles away you find a large marble thing in the middle of a city made out of limestone houses.

It is followed by the last phase in which the class examines the procedures and classroom transactions so as to improve subsequent sessions.

The inquiry training approach presented above is very useful for developing investigatory skills, problem-solving skills and skills to assess issues and arguments on their own merit.

Check yourself

Tick (✓) mark the alternative you consider to be correct:

1. Which of the following is not a goal of inquiry training strategy presented in this section:

   (a) Development of problem-solving skills.
   (b) Development of autonomy as a learner.
   (c) Mere collection of scientific information.
   (d) Applying scientific approach to social sciences.

2. Gathering data about a single event is called:

   (a) Testing conditions.
   (b) Experimenting.
   (c) Verifying.
   (d) Exploring.

3. When during an inquiry a student introduces conditions and events and verbally determines the effects of these changes, he is:

   (a) Theorizing.
   (b) Experimenting.
   (c) Verifying.
   (d) Exploring.

4. During inquiry, the content of student questions tends to alternate between phases one and two because problem solving:

   (a) Is not easy.
   (b) Shifts between obtaining data and making judgements.
   (c) Shifts between data gathering and theory building.
   (d) Is difficult for them at first.

5. Inquiry training strategy keeps the students:

   (a) In a state of confusion.
   (b) Totally involved in the learning process.
   (c) Aloof from peers.
   (d) Dependent on the teacher.

5.4 TM-II Study guide sheet - Simulation and gaming

Objectives

After going through this subsection you are expected to realize the following objectives:

1. define simulation and gaming;

2. list phases of simulation;

3. select simulations appropriate to environmental education curriculum transaction;

4. Design simulations for environmental education curriculum transaction.

Learning activities

1. Reading study sheet 'Simulation and gaming'.

2. Further readings, the following or similar ones:

   (i) Unesco: Strategies for the training of teachers in environmental education: a discussion guide, Unesco, Paris, 1980;

   (ii) N.K. Jangira, Technology of classroom questioning, National Publishing House, Delhi, 1983 (Chapter 5);

   (iii) Weil Marsha and Bruce Joyce, Social interaction models of teaching, Prentice Hall, Inc., Englewood, New Jersey, 1978 (Chapter 4).

Evaluation

After completing the learning activities, you will be required to answer questions given at the end.

Study sheet - Simulation and gaming

Simulation is an attempt to give something the effect of something else. There is a model of reality which is to be operated by the learner. The process results in learning. The quality of learning will depend upon the closeness of the model to reality. It keeps the participants actively involved in the task and is useful for

clarifying issues. It is a social interaction strategy. Elements of chance and competition convert simulation into a game and the process is known as gaming. In both, situations are created through role plays which provide the learners an opportunity to experience reality.

Running a simulation requires three stages. Briefing covers explanation of the mechanics and rules of procedures to be followed by the participants. Instructions are given by the controller (here, teacher). Sometimes instructions are in written form as well. Briefing is followed by action wherein the participants perform their roles following the rules and procedural instructions provided to them. The action phase is declared closed as the controller feels that the participants show signs of fatigue or their interest is waning. Action phase is followed by debriefing wherein the teacher helps the learners to consolidate learnings from the simulated exercises.

Simulations in the context of environmental education teaching are quite important for developing in pupils the conceptual awareness, cultural and ecological implications of the issues, acquiring competencies relating to investigation, analysis and evaluation for arriving at decisions in the light of values relating to environmental education as will be evident from the simulation outline 'National Commission on Forest Resources'.

National Commission on Forest Resources - a simulation

The simulation falls in the curriculum area of social studies and can be organized at secondary level. It purports to develop conceptual awareness about the forest resouces, cultural and ecological implications of the issues involved and promote investigation and evaluation of the forest policies in the context of ecology.

The students may be required to reach positions in forest policy before simulation. They can be provided a couple of position examples. Synthesis session (debriefing) is to be organized at the end of the simulation to further analyse the issues and complexities involved. A controller is needed for the simulation. He can be a teacher or a student.

Simulation

Briefing

The government has appointed a National Commission on Forest Resources. The Commission is to hold hearings to formulate government policy on the conservation and development of forestry in the country. The hearing purports to assess: (1) forest wealth in the country; (2) rate of forest depletion; (3) the factors determining the rate of forest depletion; (4) acceptable means to maintain a balance between deforestation and reforestation; (5) effect of deforestation on ecology. You have been invited to appear before the Commission.

Your role during the hearings will be to offer expert testimony and logical arguments reflecting your position to Commission members. In order to present testimony arguments in an equitable fashion and to maintain an atmosphere of mutual respect and acceptance, certain rules need to be followed. The rules are:

1. The order in which participants present their testimony will be determined by lot.

2. Each participant will be given opportunity to present his/her position and explain it fully. Following each testimony, the floor will be made available to other members of the Commission and/or witness to the Commission.

3. During discussion period, witnesses or Commission members may participate only on recognition of the moderator.

4. Comments and discussion on any particular issue will be limited to five minutes and may be curtailed at the direction of the Commission moderator.

At the close of the session, an attempt will be made to reach a consensus of thought within the Commission reflecting on diverse positions for formulating recommendations to the government.

Positions represented

Environmentalist:	To provide expert opinion on forest and ecology.
Agriculture expert:	To emphasize the need for deforestation for the expansion of agriculture to meet the increasing food demand.
Land-use management expert:	Reconciler of the claims of agriculture experts, environmentalist and forestry experts through land-use management.
Rural development expert:	Forest needs of rural economy. Advice on how to plan rural development programmes to conserve and develop forestry keeping the ecological balance.
Forest development expert:	Provides guidelines for development of forestry on long-term basis giving arguments in support of the premises he uses for planning.
Action:	The moderator initiates hearing.

Debriefing

Discussion and finalization of policy recommendations.

There are a number of simulations available on different aspects of environmental education. Appropriate simulation or simulated games can be selected:

Time to think and do

1. Simulation means _____

_____

_____

_____

2. Two essential elements of gaming are:

(a)_____ (b) _____

3. The purpose of briefing in simulation is:

_____

_____

4. The purpose of debriefing in simulation is:

_____

_____

5. Prepare a bibliography on simulation in environmental education (social) from the library.

6. Select a simulation on environmental education relating to the curriculum of your class and run it. Write down your experiences.

5.5 TM-III Study guide sheet - Clarifying strategies

Overview

Objectives

After completing the learning activities in this subsection, you are expected to achieve the following objectives:

1. describe at least three clarifying strategies illustrating with examples from environmental education teaching;

2. design two pupil reaction sheets based on environmental education issues;

3. list at least three guidelines for using clarifying strategies.

Learning activities

(1) Reading the study sheet 'Clarifying strategies'.

(2) Further readings:

(i) Maury Smith, A practical guide to value clarification, University Association, California, 1977 (Chapters I and II);

(ii) N.K. Jangira, Professional enculturations: innovative experiments on teaching and training, Book Work India, New Delhi, 1984 (Chapter VIII).

Evaluation

After completing the unit you will be required to answer questions given at the end and carry out suggestion activities.

Study sheet - Clarifying teaching strategies

The complexity of the emerging society has enhanced considerably the challenge to education. In the context of environmental education the problems and issues are emerging at a fast rate as an outcome of inadequately planned programmes of modernization in developing countries and indiscriminate consumerism in the developed world. This is going to be an unending process which has been faced by the child of yesterday, is being faced today and would be faced tomorrow, as well. In such a situation it is not possible to provide to the child the requisite knowledge all along. The alternative is that he is equipped with the necessary cognitive and affective skills for the purpose. As has been pointed out earlier, environmental education purports to develop specific environment-related attitudes and values. For this purpose value clarifying strategies can be employed in the environmental education curriculum transaction. Smith (1977) has spelt out behaviours related to the development of values. The three stages of the process are: (a) choosing freely; (b) from alternatives; (c) after thoughtful consideration of consequences of each alternative. Prizing implies that the individual is happy with the choice and is willing to affirm the choice publicly. It involves doing something with the choice repeatedly in some pattern of life. The behaviours comprising these three stages are quite relevant in the context of environmental education. There are different clarifying strategies for developing these behaviours in children some of which have been presented in this section.

The clarifying response

This particular clarifying strategy is based on the mode of responding or reacting to what a student says or does. The responding and reacting behaviours of the teachers help the students to clarify their thinking towards the specific problem of issues in hand. Examine the two episodes given below:

Episode I

Pupil: It is too crowded in buses.

Teacher: Right. The transport authorities are slack.

Episode II

Pupil: It is too crowded in buses.

Teacher: Is it inconvenient to you?

Pupil: Why we alone? It's inconvenient to all.

Teacher: Why is it too crowded in the buses?

Pupil: The number of buses is low.

Teacher: Two hundred buses were added last year. Why is the fleet inadequate even now?

Pupil: The number was too short already?

Teacher: Any other reason besides shortage of buses?

Pupil: Too many people come to Delhi for work.

Pupil (another): But it is the same in rural areas.

Teacher: So what?

Pupil: We are adding too many people every year. Our population growth is more than the rate of providing facilities.

Teacher: What can be the solution?

Pupil: Improve facilities and control population. Both should go hand-in-hand.

Teacher: Do you feel people should adopt a small family norm?

Pupil: Yes, I think so.

Teacher: _____

Pupil: _____

Examine the two episodes and see the ways in which the two teachers reacted to the student. It will be seen that the first response is not likely to stimulate clarifying thoughts in the pupils. But as is evident from the second episode all the questions are likely to evoke clarifying thought processes on the part of the student.

Pupil reaction sheet

As pointed out earlier that clarifying strategies outlined in the preceding subsection focused at assisting the students to think more clearly and independently about something which he has said or done. The reaction sheet being presented here purports to bring to the focus of the pupils some of the things relating to environmental education about which he has to be clear. The reaction sheet presents some of such things for the attention of a pupil in a more threatening and stimulating manner.

Examine the sample given below.

Directions: Below is given a news item. Read it carefully and answer the questions given at the end.

Later on you will have a chance to discuss your answers with a small group of your peers.

Barauni, 29 August

Yesterday, fishermen went to Ganga for fishing. They cast their net as usual. After a while they recovered their nets. There were fish in the net, but strangely enough, some of them were already dead. Their colour had also changed. Other fish which were surviving also looked unhealthy. The fishermen started raising questions at each other:

1. Why did the fish die in the river?

2. Why did their colour change?

3. Will other fish also meet the same fate?

4. What can we do to save them?

5. What will happen if we do not take appropriate measures to prevent this phenomenon?

6. Whom do you think is responsible for this?

7. Do you think that it is an inhuman death?

8. Will you be a party to any action prepared for the prevention of its cause?

_____ _____

_____ _____

_____ _____

The students can write answers to these questions in the reaction sheet and discuss in group.

This type of reaction sheet can be designed for bringing to the attention of pupils different problems and issues covered in the area of environmental education. The designing of reaction sheets may vary so far as the theme and the material are concerned. The issue can be drawn from a news item, a textbook or controversial issues concerning environmental education. They are, of course, based on provoking statements.

Critical incident sheet

Here the pupils are required to report every week one incident involving his action for improving environment (conservation, prevention of its deterioration, development of consciousness in others, etc.) during the preceding week. The teacher can write clarifying questions on the margin of the sheet for stimulating the pupil to further thinking and weigh the consequences of his actions. The design of the critical incident sheet is given below:

Critical incident sheet

Just like other human beings you are in constant interaction with the environment. On some of your actions relating to the environment you have a reason to feel proud of. Describe in about 100 words any incident or your action relating to the environment on which you can feel proud of:

_____

Teacher clarifying questions, if any _____

If the pupils like and they are willing to share their critical incidents voluntarily, these may be read out in the class. Reading can be followed by discussion.

Open-ended questions

The open-ended questions provide the teacher with the method of getting the student to reveal some of their attitudes, beliefs and activities relating to various aspects of environmental education content. Some of the sample open-ended questions can be:

1. My best friends in my garden are _____

2. I never pluck flowers because _____

3. I don't throw away waste in the open because _____

4. Some people are indulging in damage to the environment when _____

5. If I am asked to devote my full life for the improvement of the environment I would _____

The use of open-ended questions is quite helpful because it is economical in terms of time, a teacher can write a single question on each paper or write some on the blackboard for students to complete. This helps the students to reflect. The teacher can read some papers anonymously to the class and ask if any class member has a question which he can refer to the anonymous author.

Role playing

Role playing offers a good opportunity for personalizing the actions in a particular situation. It is quite interesting to the children as they enjoy play acting and miming. The teacher can design role playing situations with a structure, but it is not essential. The controversial and conflict situations have a good potential for role playing. The simulation exercise presented earlier provides a role play situation.

For the effectiveness of clarifying teaching strategies it is essential that the teacher builds a climate of confidence, respect for independent opinions of the students on environmental issues and avoids forcing his own views on the students. The personal opinions if expressed in private or in writing should be made public or brought to discussion only with the prior consent of the student concerned.

Think and do

1. Give two reasons for using clarifying strategies in environmental education teaching:

   (a) _____

   _____

   (b) _____

   _____

2. Select a news item relating to environmental education (social) from the newspaper and design a pupil reaction sheet with at least four clarifying questions.

3. Open-ended questions can be used easily, because:

   (a) The questions are open.
   (b) Require less time for completion.
   (c) Provide precise thinking.
   (d) None of the above.

4. Clarifying responses help the pupils to:

_____

_____

_____

5.6 TM-IV Study guide sheet - Beyond the school-wall experience

Objectives

After completing the learning activities you are expected to realize the following objectives:

1. state at least two reasons for providing 'Beyond the school-wall experiences' in environmental education teaching;

2. list the type of activities that can be planned by a teacher under this area for environmental education teaching;

3. enlist the activities under the three steps for organizing 'Beyond the school-wall experiences' for environmental education teaching;

4. plan a field activity to realize selected environmental education objectives related to specific environment education content.

Learning activity

1. Reading study sheet 'Beyond the school-wall experiences'.

2. N.K. Jangira, Education for peace, international co-operation for development and human rights, Department of Teacher Education, NCERT, New Delhi, 1984 (pp. 34-36).

3. Organizing a field trip to study 'Culture and environment' in a selected area.

Evaluation

After completing the learning activities, you will have to answer questions given at the end.

Study sheet - Beyond the school-wall experiences

Environmental education permeates every aspect of human life. Man is surrounded by ecosystems and subsystems. He is in constant interaction with living systems and non-living systems in the environment which is concentric in nature. We have immediate environment in the home, the classroom, school, community around and remote environment. So merely classroom experiences may not be sufficient for achieving the environmental education curriculum goals. Beyond the school-wall experiences are indispensable for widening the horizon of the student regarding different dimensions of environmental education.

Beyond the school-wall experiences cover a variety of activities like field trips, excursions and simply field observations. Community and ecological surveys are also covered in this class of experiences. However, the effectiveness of such

experiences depend on the extent to which they are planned systematically, implemented with a sincerity of purpose followed up adequately and utilized properly.

The field work to be systematic follows sequential steps. Preparation starts with an initiation by the teacher explaining its purpose and raising questions to motivate students who also contribute to the pool of such questions. After the motivational stage of preparation organizational details are worked out co-operatively. If necessary, pupils are divided into small groups with specific tasks allocated to each. The groups develop tools or logs to be filled in. The groups and individuals carry out the assigned responsibilities. In the experiencing stage they observe and collect data. Discussion and drawing of inferences help in the consolidation of learnings. The activity is to be followed up by making of reports, display of collections and implementing environmental education related action guidelines.

Sample field study - Developing the township of Seempur

The purpose of the field study is to trace the growth of Seempur town over the past four decades with focus on variables influencing its ecology - the demographic changes, growth of housing, development of services like health, education, sanitation, roads, etc., growth of agricultural and animal husbandry practices and industry, development of marketing patterns, sanitation and disposal of water, growth of transport and communication, etc.

Preparation and planning

The objectives are explained and the tasks are identified. The class is divided into five groups. One group is to collect data on demography, second on services (health and education), third on agricultural and dairing practices, fourth on transport and communication, and fifth on the environmental education problems specific to the locality. The mode of data collection is also finalized. Data collection from written records of the Town Area Committee/Municipality (demography, expansion programme, etc.), records of schools and hospitals, interview with officials and parents, survey of facilities like communication, transport and vocational input, organizing a seminar of about 25 persons of the locality, observation of practices, collection of specimens, if available. The proformas for the collection of information will also be prepared. For example, a questionnaire for identifying changes in agricultural practices, environment related concerns and actions taken to offset adverse effects on environment, if any.

Change in agricultural practices
and environmental related concerns

Agricultural activity	Year	Mode	Environmental related concern	Environmental education related action, if any
Tilling	1951			
	1966			
	1981			
Sowing	1951			
	1966			
	1981			

Agricultural activity	Year	Mode	Environmental related concern	Environmental education related action, if any
Interculture operation	1951			
	1966			
	1981			
Disease curation	1951			
	1966			
	1981			
Manuring	1951			
	1966			
	1981			
Storing	1951			
	1966			
	1981			
Marketing	1951			
	1966			
	1981			

While completing the questionnaire, regarding disease prevention and cure the use of insecticides and pesticides have effects on the environment. The same case is with the use of fertilizer. How has some action been planned to offset their adverse effects? Similarly, interview schedules can be prepared.

During the consolidation phase, such questions as given below can be discussed:

Has the township grown fast during the last three decades?

What has been the pattern of growth in different areas? What are the trends?

Has the growth been planned growth or is it ad hoc?

Were environmental education related concerns taken into account while planning? If not what can be done now?

How has demographic growth affected the services in the town?

How has changing agricultural facilities/new practices related to the quality of the environment?

What other actions would you suggest to the town administration to improve the quality of environment?

What can the school do towards this end?

The group reports can be prepared as discussed. The final report consolidating the group reports may then be prepared. Action guidelines for different agencies prepared and each agency approached as follow-up action.

Check yourself

Tick mark (✓) the best choice:

1. Beyond the school-wall experiences are indispensable in transacting environmental education curriculum because:

   (a) Pupils feel motivated.
   (b) Releases pressure on school activities.
   (c) Broadens the horizon of pupils.
   (d) Provides direct experiences.

2. The essential condition for organizing effective beyond the school-wall experience is:

   (a) Adequate arrangements for transport.
   (b) Systematic planning and preparation.
   (c) Formation of small groups.
   (d) Community support for the activities.

3. Follow-up activities are essential:

   (a) Utilize the gains.
   (b) Strengthen student learnings.
   (c) Enriching learning activities.
   (d) Make activities effective.

4. Report writing after beyond the school-wall experiences helps in:

   (a) commiting the pupils to action.
   (b) consolidating pupil learnings.
   (c) Fulfiling a condition of field study.
   (d) None of the above.

5. Small group interaction during beyond the school-wall experiences:

   (a) Develops social learnings.
   (b) Consolidates learnings.
   (c) Clarifies issues and problems.
   (d) Commits the group to action.

CHAPTER 6

ACTIVITIES AND EXPERIMENTS FOR TEACHING/LEARNING THE ENVIRONMENTAL DIMENSION IN SOCIAL SCIENCE SUBJECTS IN SECONDARY SCHOOL

Environmental education is a problem-solving approach. Its teaching/learning is meaningful only when the acquired knowledge and skills are helpful in dealing with real life situations. These may be achieved by including such activities and experiments that will enable the students to make decisions or to choose between alternatives for solutions of the environmental problems.

The suggested activities and experiments in this module are only examples to help pre-service teachers to make teaching/learning in environmental education more meaningful. Similar activities may be designed to suit the local needs and the comprehension level of the students.

Activities and experiments in this module are based on the contents of Chapters 3, 4 and 5 dealing with the need and basis of environmental education, essential knowledge about the environment and its problems respectively. Mainly three kinds of activities have been suggested in this chapter - questions and answers, class discussion and project work including collection of information from primary and secondary sources, processing and preparation of reports followed by class discussion, exhibition or taking suitable action.

6.1 Suggested activities/experiments for the need and basis of environmental education

1. Answer the following questions briefly:

   (i) What prompted the United Nations to convene a conference on the human environment in Stockholm in 1972?

   (ii) How can education help solve the environmental crisis?

   (iii) What is the overall goal of environmental education?

   (iv) How does the Unesco-UNEP International Environmental Education Programme help in promoting environmental education?

   (v) How are environmental problems of developed countries different from the developing countries?

2. 'Environmental education is not a new discipline but a new dimension in the education system'. Explain.

3. Fill in the blanks with suitable words:

   (i) World _____ Day is celebrated on 5 June every year. (Environment/Wildlife)

   (ii) Intergovernmental Conference on Environmental Education was held at _____ in 1977. (Stockholm/Tbilisi)

(iii) Environmental education is a continuous _____ process. (formal/lifelong)

(iv) Besides, ecological concepts, aspects of _____ environment should also form part of environmental education courses for social science teachers and supervisors. (social/natural)

(v) Success of the environmental education programme depends primarily on _____, who are the central figures in schools. (teachers/supervisors)

4. In the classroom the pre-service social science teachers may go through the aims and objectives of environmental education. Afterwards they can examine the stated objectives of secondary-school social science courses of their own country to see if any of the environmental education objectives has fully or partially been covered. Two separate lists can be prepared - one for those objectives which are included already and another for those which are not. The class can discuss whether such objectives may find a place in the traditional social science subjects. If yes, the class can discuss the ways to include such objectives and can also suggest appropriate places to do so.

6.2 Suggested activities and experiments for essential knowledge about the environment

5. List five objects each of natural and man-made environment.

6. Which are the three interlocking systems of the earth?

7. Why is biosphere important?

8. What is an ecosystem?

9. Why is the ozone layer important for us?

10. Why is water a limiting factor for distribution of species?

11. What is a metamorphic rock and how is it formed?

12. How is soil formed?

13. What makes natural cycles operational?

14. What is insolation?

15. What is a food chain?

16. How is carbon withdrawn temporarily from the carbon cycle?

17. What is shifting agriculture?

18. What helped the industrial revolution?

19. What were the major consequences of the industrial revolution?

20. What is economic imperialism?

21. What is the new international economic order?

22. What are the ways in which man has tampered with the natural environment?

23. What is environmental ethics?

24. What is a Partial Test Ban Treaty?

25. How can individuals and groups contribute in environmental decision-making?

26. Distinguish between:

    (i) physical environment and biological environment;

    (ii) natural environment and man-made environment;

    (iii) igneous rocks and sedimentary rocks;

    (iv) terrestrial ecosystem and aquatic ecosystem;

    (v) tropical zone and temperate zone;

    (vi) herbivores and carnivores;

    (vii) producers and consumers;

    (viii) food chain and food web;

    (ix) biotic and abiotic components of the environment;

    (x) replenishable and non-replenishable resources.

27. Field trip to an area such as a forest, a farm, a pond or a coastal area, where students can identify various components of the environment. Divide the class into two groups and let them prepare a list of biotic and abiotic components of the environment separately. Discuss the various interrelationships existing between different components of the environment.

28. Students may be asked to collect clippings from newspapers and magazines about large projects such as an iron and steel plant, a thermal plant, a dam or a petro-chemical complex. Let them find out the importance of each project and how it will be beneficial to the area. What kind of environmental changes are expected after completion of the project?

29. Students may prepare a chart of the hydrologic cycle to show the movement of water from hydrosphere, to atmosphere, to lithosphere and back to the hydrosphere.

30. Students may find out the ways in which human activities affect the geo-chemical cycles.

31. Students may construct a graph showing the population growth of their own country and compare it with the population growth of one developing country and one developed country.

32. Students may construct age pyramids to illustrate age structure of their own country. On the basis of the age pyramid, the class can discuss the ratio of the young dependent group to the productive segment of the population and its impact on the socio-economic conditions of their country.

33. Class discussion may be organized on 'rapid population growth is the most important factor in creating environmental problems'.

34. Discuss the impact of industrialization - urbanization and answer the following:

    (a) How can the life-styles of people harm the environment?

    (b) How can your life-style harm the environment?

    (c) Do you feel that people, if necessary, should change their life-styles of maintain a healthy environment?

    (d) Can you change your life-style to help maintain a healthy environment?

6.3 Suggested activities and experiments for essential knowledge about the problems of the environment and their solutions

35. What is environmental degradation?

36. Which are the major environmental problems of the developed countries?

37. Which are the major environmental problems of the developing countries?

38. What is meant by resource depletion?

39. How does mining affect the environment?

40. Why is vegetation cover important for us?

41. 'Environmental pollution leads to the deterioration of the quality of the environment'. Explain.

42. Which are the main forms of wastes? How are they disposed of?

43. Which are the three major sources of atmospheric pollution?

44. How are fertilizers and pesticides harmful to the biosphere?

45. Distinguish between:

    (i) deforestation and afforestation;

    (ii) erosion and sedimentation;

    (iii) pollution and depletion;

    (iv) salinization and alkalinization;

    (v) flora and fauna;

(vi) metallic minerals and non-metallic minerals;

(vii) communicable diseases and degenerative diseases.

46. Fill in the blanks with suitable words:

(i) Deforestation leads to soil _____. (erosion/weathering)

(ii) Irrigation in dry lands sometimes leads to _____. (salinization/alkalization)

(iii) Fossil fuels are _____ resources. (replenishable/non-replenishable)

(iv) Minamata disease was caused due to _____ poisoning. (lead/mercury)

(v) Desertification is an environmental problem of _____ nature. (global/regional)

(vi) _____ has been eradicated in recent years. (malaria/small pox)

(vii) Obesity is a problem of _____ countries. (developing/developed)

(viii) Malaria and schistosomiases remain widespread diseases of the _____. (temperate zone/tropical zone)

47. Find out from your own neighbourhood some of the local natural resources that are being exploited now but were not used some years ago.

48. Make a list of all the major changes that have taken place during the last ten years in the cultural landscape of your neighbourhood.

49. Prepare bar graphs showing production of the following in your country during the last decade: (i) coal; (ii) petroleum; (iii) hydroelectricity. Has there been any change in the production? Discuss the nature and causes of these changes.

6.4 Project work

Project I

Main theme: Sanitation in the locality

Need and purpose

The problem of sanitation has been aggravated because of unplanned urbanization, industrialization and concentration of population in cities. Such insanitary conditions exist in villages also. These conditions lead to environmental pollution, sickness and epidemics. Therefore, our environment should be kept neat and clean. It has rightly been said, 'cleanliness is next to Godliness'.

Objectives

(1) To help the students understand that hygiene and cleanliness lead to prevention of diseases.

(2) To make the students develop the habit of cleanliness and realize its importance in everyday life.

(3) To help them realize that insanitary conditions call for action on the part of those who live in the community.

(4) To make the students aware that qualitative improvement in the environment guarantees a better life.

Procedure

The class should be divided into three groups for surveying the classroom, campus of the school/institution and the neighbourhood. Before survey, a questionnaire should be prepared including all aspects of sanitation for which information is required.

(a) The first group will survey the classroom.

(b) The second group will survey the campus of the school/institution.

(c) The third group will survey the neighbourhood.

After the survey, the groups will meet and the reports will be read out by the leaders of the groups. This will be followed by class discussion to find out different ways and methods to tackle the problems which have been highlighted in these reports.

Proposed action

Inside the school/institution campus

(a) To seek the permission of the head of the school/institution and the co-operation of other members of the staff to help in carrying out the programme.

(b) To arrange the necessary materials, e.g. bleaching powder, phenyle, naphthalene balls, wicks and baskets, spades, dustbins, spitoons to keep the school/institution area clean.

(c) During this programme wall charts may be put up. Some other posters bringing out the theme of sanitation and cleanliness may also be put up. Pictorial posters giving instructions about observing cleanliness such as 'Don't spit', 'Keep your campus clean' and 'Don't throw litter', may be displayed.

(d) Competition of wall posters on cleanliness and sanitation may be organized.

(e) Student leaders may present the findings of the survey before other students and suggest ways to maintain cleanliness in the school/institution campus.

Outside school/institution

(a) To meet the families in the neighbourhood and to seek their co-operation in removing potential health hazards. They should give lead by starting work themselves.

(b) To approach proper authorities for the solution of the problem, failing which to write a letter of complaint to the health officer or to the editor of the local daily to draw it to their attention.

(c) To organize social welfare camps, if possible, with the help of some leading personalities of the neighbourhood.

(d) To organize an exhibition to make the people aware of the sanitation and health programmes.

Survey sheet

A survey is to be carried out to find out sanitary conditions within the school/institution campus and the adjoining areas of the school/institution.

1. Area to be surveyed, i.e. school/institution or neighbourhood:

_____

2. Names of the group members in each survey party:

Group A	Group B	Group C
1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
4. _____	4. _____	4. _____
5. _____	5. _____	5. _____

3. Name the localities surveyed and mention whether they were clean or unclean:

Localities	Clean/unclean
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____

4. Name of the locality and causes of insanitary conditions (e.g. throwing of garbage, open drains, waterlogging, lack of public conveniences):

Locality	Causes of insanitary conditions
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____

5. Provisions for sanitation in the neighbourhood:

(1) Number of garbage pits: _____

(2) Nature of garbage pits i.e. enclosed or open: _____

(3) How often is garbage removed?: _____
(Once a week, twice a week, every day)

(4) How is garbage disposed of?: _____
(Dumped, burnt or any other method)

(5) Nature of drainage: _____
(Covered or open)

(6) Is drainage cleaned regularly? Yes/No: _____

(7) Number of public conveniences in the neighbourhood: _____

(8) Are these cleaned regularly?: _____

(9) Any other provision: _____

6. Provision for proper sanitation in the school/institution campus:

(1) Is there a waste paper basket in every class? Yes/No

(2) Is the waste paper basket cleaned every day? Yes/No

(3) Number of dustbins in the campus.

(4) Are these dustbins cleaned every day? Yes/No

(5) Number of toilets?

(6) Are these toilets clean? Yes/No

(7) Any other provision.

7. Has there been any case of epidemic in your neighbourhood during the last two years? If yes, name the disease and state whether it was air borne or water borne.

Self-evaluation sheet

Name of the school/institution: _____

Name of the student: _____

Age: _____ Class: _____

1. How would you improve the sanitary conditions in your school/neighbourhood?

_____

_____

_____

2. Which authority would you approach to improve the sanitary conditions?

_____

_____

3. Any other suggestion:

_____

_____

Project II

Main theme: Water supply

Need and purpose

Adequate supply of standard quality of water is essential for human consumption and other uses. However, water is contaminated in several ways affecting the human health. It is, therefore, essential to know the nature of supply, sources of water pollution, and how to maintain the quality of available water.

Objectives

(1) To help the students know the various sources of water supply.

(2) To help students know the different uses of water in the community - agriculture, industrial, domestic.

(3) To help them find out the ways the water gets polluted in the neighbourhood, and

(4) To make students aware of the process of water purification.

Procedure

The class can be divided into small groups to work on different aspects. These groups will find out the sources of water supply, various uses of water in the locality, nature of water pollution and their sources and the ways to purify water for human consumption.

After the survey, different groups will discuss the world report together in the class and will suggest measures to maintain/improve the nature and quality of water supply in the locality.

Proposed action

(1) To meet the community members in the locality and seek their co-operation in conserving water and maintaining its quality.

(2) To approach the proper authorities for the solution of any problem related with water supply, failing which to write a letter to the editor of the local daily.

(3) To organize an exhibition to create public awareness regarding water conservation and its quality control.

Survey sheet

A survey will help in knowing more about various aspects of water supply in the locality.

1. What are the sources of water in your community (e.g. tank or pond, spring, river, well, tap)?

2. How much water is required in your house every day (approximate litres, gallons)?

3. Is there any problem in getting the required amount of water? (State the nature of the problem)

4. Make a list of all the ways in which you and your family members use the water.

5. Classify the uses of water in the community into necessary and luxury uses.

6. Is there any seasonal variation in the water supply? If yes, state nature and causes of variations.

7. Take water samples in small jars from two or three different places and label them A, B and C. Allow the water to settle for 24 hours. Has there been any deposits in the bottom of the jars? Is there any difference in the amount of deposits in the three jars? Compare and write down your findings for all three samples.

Jar A	Jar B	Jar C

8. What could be the sources of water pollution in the locality (e.g. discharge of pollutants, open drains nearby)?

9. Is water purified at the source of supply? Yes/No

10. If yes, how is water purified?

_____

_____

11. If no, what can be done to purify water before use?

_____

_____

12. Do you conserve water? Yes/No

13. If yes, how do you conserve water?

14. If no, what are the ways in which water is being wasted?

Self-evaluation sheet

Name of the school/institution: _____

Name of the student: _____

Age: _____ Class: _____

1. What steps would you take to improve the quality of water in your locality?

_____

_____

2. What steps would you take to conserve water in the locality?

_____

_____

Project III

Main theme: Safeguard against spread of diseases (malaria)

Need and purpose

For improving the quality of life, it is necessary that people take appropriate measures to safeguard themselves against diseases. Some of the diseases which spread due to unhygienic conditions may be checked and prevented if people take precautionary measures beforehand. Unless each and every individual is aware of and is prepared to take the necessary steps required for its prevention, malaria will continue to be a health hazard.

Objectives

(a) To enable students to understand the factors and mechanisms which cause malaria.

(b) To help students learn the skills required for taking steps that would prevent the occurrence of malaria.

(c) To help students develop consciousness for environmental cleanliness necessary for the prevention of malaria.

Procedure

The project will require group activity and will consist of the following steps:

(a) Seeking co-operation of experts from the local health centres, who will enlighten the students by providing basic information regarding the nature and causes of the disease. Help of teaching aids such as slides, films, posters, etc., may also be useful.

(b) Students may form groups and survey the locality to find out sources of mosquito breeding. Through discussions in the class, they can exchange their views on their findings.

(c) Students may be exposed to the various measures adopted to check mosquito breeding. For example, spreading of gammaxine, DDT and kerosene oil. Besides, they should also be introduced to various mosquito repellent creams and oils and anti-mosquito devices like use of mosquito nets, fixing of wire nets on windows, etc.

(d) Students may organize campaigns to plug and destroy various sources of mosquito breeding and to educate the community to check mosquito breeding. On this occasion, talks may be arranged on causes, transmission and methods of controlling malaria by the malaria surveillance workers and malaria inspectors from the local health authority.

(e) Posters and charts may be prepared on different aspects of malaria such as causes, transmission and methods of control.

(f) Report of the project may be prepared and discussed in the class.

Evaluation

Evaluation of the project will be made by assessing the method of preparation, method of implementing the project and studying its impact on the community. This may be done by finding out how much the community members are conscious of not allowing water to accumulate and stagnate in the neighbourhood, thereby checking the mosquito breeding. The real indicator of the success of the project will be a decline in the number of malaria cases, a record of which may be obtained by the local health office as a follow-up action. It would be proper to conduct an annual survey just after the rainy season to locate malaria cases and places favourable for mosquito breeding. This should be followed by appropriate action so as to check the spread of malaria.

Project IV

Main theme: Impact of a steel plant

Need and purpose

Launching of a big project such as construction of a steel plant is going to have its impact on the environment of the surrounding region. This impact would be

felt both on the natural as well as the social environment. The purpose of this project is to find out how a man's creation affects the surrounding region.

Objectives

(1) To help students realize the amount of natural resources, money and human labour which are involved in such a developmental activity.

(2) To help them understand how such a plant would help in improving the socio-economic conditions of the people of the surrounding region.

(3) To enable students to realize the nature and kinds of environmental hazards which are related with this activity.

Procedure

The class may be divided into small groups to work on the different aspects. These groups will find out the raw materials used in the industry, and their sources; the nature, kinds and quantity of production; modes of transport used for carrying the raw materials and finished products; infrastructural facilities required for the industry, total work force and their classification into skilled, semi-skilled and unskilled labourers, managers and other officers; the nature and amount of wastes and their disposal methods; location and distance of human settlements from the factory site; occupational pattern, income and any other information.

After the information is collected and processed, diagrams and charts may be prepared to depict the main features such as production, consumption of raw materials and waste disposal. Besides, the socio-economic conditions of the people can be analysed with reference to two points of time for comparison. For example, the total number of people from nearby settlements engaged in primary, secondary and tertiary activities such as agriculture, industry and trade in the year before the construction of the plant and in the year after the production started in the plant. This may be helpful in comparing the change in the occupational pattern. Prepared reports may be discussed in the classroom. If few environmental problems have been noticed due to the construction of the plant and its inadequate arrangements for safeguarding the environmental health, efforts may be made to seek co-operation from the community in pursuing the matter with the concerned authorities for taking the necessary measures.

Survey sheet

An attempt has been made to include a wide variety of questions in this sheet so as to gather the maximum possible information. This may be modified to suit the local needs.

1. Where is the steel plant located?

_____

2. How was the land used before the construction of the plant?

_____

3. Did the land belong to local people or the government?

_____

4. If the land belonged to local people, has there been any compensation made? Yes/No

5. How has the compensation money been utilized by the people?

_____

_____

6. What is the capacity of the plant?

_____

7. What raw materials are used in the plant?

_____

_____

_____

8. From where are the raw materials produced and how? Name each raw material, its annual requirement and mode of transport, i.e. railway, roadways.

_____

_____

9. What kinds of infrastructural facilities were required to construct the plant (i.e. transport lines, water supply, power)?

10. What are the major products of the plant?

_____

_____

11. Are these products used locally or sent outside? If both, mention proportion in percentage?

_____

12. How many people work in the factory?

Officers

Labourers

1. Skilled _____
2. Semi-skilled _____
3. Unskilled _____

13. Are they local or migrants?

Number of local labourers

_____

Number of migrant labourers

_____

14. What kinds of water are discharged from the factory?

Solid _____

Liquid _____

Gaseous _____

15. What is the mode of waste disposal?

_____

_____

16. How far are the settlements located from the factory?

_____

17. Are housing facilities adequate for the present population?

_____

18. As there been any change in sanitary conditions due to population increase after the plant's construction? Mention the nature of change and give reasons for that in ten lines.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

19. Do you feel that the location of the factory is in any way harmful to the environment? If yes, how?

_____

_____

20. What was the total population of the settlements in the neighbourhood of the plant before the construction of the plant? (The previous census before the plant's construction.)

_____

21. What is the latest population size of the settlements after the plant had been constructed? (Latest census data)

22. Has there been any change in the occupational pattern of the people? If yes, mention the nature of change.

_____

_____

23. What kind of socio-economic changes do you notice in the region since the plant has been constructed? (Income, standard of living, job opportunities, progress in agriculture or any other noticeable feature.)

_____

_____

24. Do you feel that the construction of a steel plant is beneficial for the development of the region? Give reasons for your answer.

_____

_____

CHAPTER 7

EVALUATION

7.1 Study guide sheet - Evaluation in environmental education

Objectives

After going through this unit you are expected to realize the following objectives:

1. list at least three functions of evaluation in the context of environmental education;
2. distinguish between formative and summative evaluation;
3. describe at least three modes of evaluation in the context of environmental education;
4. list sources of items for evaluation in environmental education.

Learning activities

1. Reading study sheet 'Evaluation in environmental education'.
2. Additional readings such as the following:
   (i) Popham, W.J., Modern educational measurement, Englewood Cliffs, Prentice Hall, 1981.
   (ii) Jangira, N.K., Technology of classroom questioning, National Publishing House, Ansari Road, Darya Ganj, Delhi, 1983 (Chapters 3 and 4).
3. Writing test items on a topic of choice.

Evaluation

After the completion of the unit you will be required to answer questions given at the end.

7.2 Study sheet - Evaluation in environmental education teaching

Evaluation focus

Environmental education as a curriculum area has unique characteristics of its own. It follows the multidisciplinary infusion model of curriculum. The objectives of this area are much wider in scope as they not only cover knowledge and awareness, the skills and values, but are action-oriented. The teaching methodologies matching the objectives employed in transacting environmental education curriculum also have a variety. The evaluation in environmental education teaching should also match the unique characteristics of this curricular area, its specific objectives and the teaching methodologies employed to achieve the stipulated goals.

Three major functions of evaluation in environmental education teaching should be kept in view. Firstly, it should help in evaluating pupil progress at different

stages in teaching. Secondly, it should help in diagnosing pupil difficulties in learning. Thirdly, it should serve as a mechanism for improving teaching. The three functions are not mutually conclusive. They are interrelated and interdependent with a lot of overlapping. For example, pupil progress may point to the strength and weaknesses in his learning, diagnosis may provide the cause(s) of shortfall in learning, which in turn, provides guidelines for modifying teaching strategies so as to effect better learning in pupils. The three functions have however been analysed into three separate components for the convenience of understanding. The three functions imply that evaluation in environmental education is a continuous activity and is to be conducted at different stages of teaching. This type of en route evaluation is also termed as formative evaluation which forms a feedback based mechanism for regulating teaching procedures adopted to the needs of pupils. The final evaluation is termed as summative evaluation. It provides an estimation of the outcomes of teaching in terms of pupil attainments. The focus of evaluation in environmental education teaching is on the degree to which the pupils are achieving the objectives of a particular lesson, unit or a module. This assessment requires measurement of some kind. The type of measurement and tools of measurement depend on the objectives to be assessed.

The non-formal nature of environmental education learning though restricts limitation on the evaluation, yet reliable and valid measurement are indispensable to assess pupils' progress and use the data for improvement of pupil learning in the environmental education curriculum area.

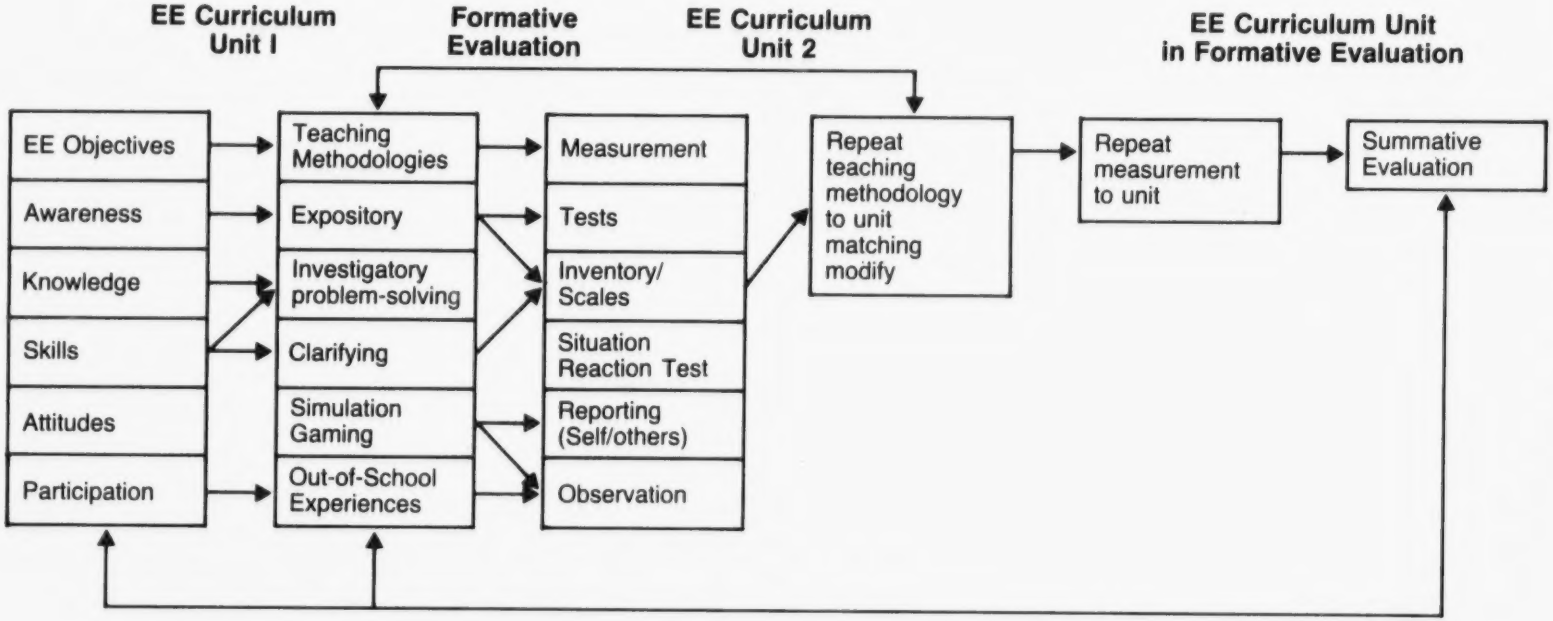
The process of evaluation in environmental education teaching, its components and its utilization have been conceptualized in Figure 2.

The diagram illustrates environmental education teaching objectives, methodology and evaluation match. It also indicates feedback loops at the bottom of the figure which provide guidelines for modifying the match if necessary as indicated by arrows in the upper part of the figure.

Evaluation mode

Figure 2 stresses the need for matching environmental education objectives and mode of evaluation. The non-formal nature of environmental education learning in a variety of situations, particularly in out-of-school situations put limitations on structured and perfect goal oriented evaluation. For example assessing the attainment of environmental education objectives requires some form of measurement. Measurement, in the scientific sense, is the process used to determine the degree to which the learners reflect the specific behaviours or characteristics envisaged in a particular teaching-unit. For example, if one intends to measure the extent to which students are involved in citizenship action relating to environmental issues, direct observation would be the most valid source of information. But, it may not be always feasible to have direct observation evidence due to the wide expense of environmental action, both in terms of space as well as time. One may not exactly know where and when environmental action is likely to occur. Even if these two points can be located, the process is enormously time-consuming and expensive. Naturally, the teacher turns to some other source of evidence to measure this information. He uses self-reporting as a means to this end or else reporting from others, parents, peers or community members - can also be considered. However, reporting is to be used with caution to ensure a reasonable level of validity. Situation - reaction tests, observation of behaviour in simulated situations, inventories and rating scales can also be used to measure attitudes and values. Tests, particularly criterion reference tests and teacher-made tests can be used for knowledge and awareness of the pupils. So this section deals with different evaluation modes and the tools of evaluation in the context of environmental education curriculum transaction.

Figure 2: Evaluation and Improvement of E.E. Teaching



Tests: Tests are used to measure the objectives relating to knowledge and awareness. It is not necessary that norm reference achievement tests are used. Criterion reference tests and teacher-made tests will be helpful to measure this domain of objectives. Self-scoring, multiple choice tests can be quite helpful in this work. Framing of questions in these two areas have been extensively illustrated in the technology of classroom.

Questioning: Test item banks are also available to help the teachers. Sample questions are given below:

Smokeless automobiles are needed, because:

(a) it saves fuel cost;

(b) it avoids environmental pollution;

(c) it keeps the engine in condition;

(d) it looks odd.

Find out the names of four environmentalists from your own country. List the names below:

1. _____ 3. _____

2. _____ 4. _____

Situation reaction tests

There are areas of learning, particularly those dealing with reactions, attitudes and values relating to environmental issues and actions which cannot be measured through simple tests. But this area is an important objective in environmental education curriculum and teaching. So, the situation reaction tests which defines the situation and asks for learner reactions considering himself in the situation. The situation reaction tests can be in the form of presentation of the situation and providing alternatives for selecting the one that is nearest to his choice.

Observation in simulated situations

It is not possible to observe pupils directly in real situations involving environmental issues or actions. So, simulated situations involving environment-related decision-making, issues or actions can be designed. The pupil perform their roles in the simulated situations which can be systematically observed and used in evaluation.

Example:

You are appearing before the Commission on Water Management appointed by government. What is the viewpoint you will present before the Commission?

You may discuss and formulate your viewpoint.

Observation by pupils and teachers

Self-reporting

The pupils can be required to prepare brief reports on the environmental action or the viewpoints they projected in discussions relating to environmental issues. This can be done periodically. For example, the writer did it once a week. On Monday, students were required to give a write-up on at least one environment-related action. The reporting was semi-structured in the sense that the students were required to have this frame in mind while preparing the write-up. They were required to (i) define the situation; (ii) viewpoint expressed or decision taken; (iii) action performed; (iv) the rationale for the decision-action.

Other reporting

In order to support self-reporting, and as well as for mutual validation, questionnaires can be formed for reports about students from their parents, peers or community members. The questionnaires have to be brief and to the point.

Rating scales

Like scales, reaction scales, attitudes and value scales can be used for measuring affective characteristics.

Systematic observation

Observation was pointed out in the context of simulated situations for evaluation. Systematic observation here is in a real situation. Observation notes are kept and collected for drawing references.

The mode of evaluation and the tools for measurement enlisted above are suggestive in the sense that they will have to be specifically selected by teachers in situations and according to the objectives. There is to be always competing claims between desirability and feasibility in respect of the validity of measurements as was pointed out in the beginning itself. The teacher will have to reconcile the claims in view of the situations and available facilities.

Utilization of evaluation

The results of the measurement are utilized by the teacher for providing feedback to pupils by way of pointing out their strengths and weakness. The feedback is provided in a way that their learning behaviour is reinforced and self-concept is improved. It should neither hinder their learning nor lower their self-concept. This particular objective will be achieved, if the teacher also receives feedback, feedback on pupils learning difficulties, feedback on the extent to which the teaching methodologies and materials selected had been effective in pupil learning.

It is used to modify the teaching behaviour, use alternative teaching procedures and help pupils in modifying their learning behaviours so as to bridge the gap between the intended and observed pupil behaviours evaluation data is continuously used for adjusting teaching to the requirements of the pupils, thereby improving its effectiveness. Finally this data is used to evaluate the environmental education curriculum which has already been discussed in the unit on curriculum.

7.3 Try yourself

Environmental education curriculum follows multidisciplinary approaches. State two implications of this characteristic of environmental education curriculum for evaluation in environmental education.

1. _____

2. _____

Environmental education has citizenship action to be the final goal. State two implications of this objective for evaluation in environmental education.

1. _____

2. _____

Give one situation each in environmental education teaching where the following are used for evaluation.

1. Self-reporting _____

_____

2. Other reporting _____

_____

3. Rating scales _____

_____

4. Situation reaction test _____

_____

1. The situation reaction test as a tool of measurement in environmental education teaching is useful because it (tick mark the correct choice):

   (a) is realistic;
   (b) is comprehensive;
   (c) is an indirect measure;
   (d) is economical to assess action.

2. Observation of pupil behaviour in simulated situations can be used in evaluation in environmental education teaching, when (tick mark the correct choice):

   (a) direct observation is not feasible;
   (b) reporting is doubtful;
   (c) tests are not available;
   (d) none of the above.

3. Rating scales are used for measuring:

   (a) knowledge level of the pupils;
   (b) pupil environmental action orientation;
   (c) attitude to environmental issues;
   (d) decision-making abilities of the pupils.

Answers

1. (c) 2. (a) 3. (c)

CHAPTER 8

STRATEGIES FOR PLANNING, DEVELOPMENT, IMPLEMENTATION, MANAGEMENT AND EVALUATION OF THE ENVIRONMENTAL DIMENSION OF SECONDARY-SCHOOL SOCIAL STUDIES CURRICULUM

Curriculum development is a process of translating educational goals into practice. Like any other curricular area, environmental education curriculum requires appropriate strategies to plan, develop, implement, manage and evaluate the realization of goals of environmental education.

Environmental education is not a separate discipline but is an approach. It draws its content from different disciplines. For example, many social science subjects such as geography, history, economics, political science and sociology include some aspects of the environment in their content areas. Topics like study of population, human settlements, food, water, diseases, poverty, degradation and depletion of various resources and conservation of resources have been parts of the content of different subject areas. Like environmental education, social science subjects also strive for national development and social consciousness. As such social sciences can contribute a lot to promote environmental education. All that is required is proper planning to facilitate development of environmental education curriculum, its implementation, management and evaluation. Some of the concepts such as those of ecology which are fundamental to the understanding of environment needs to be integrated with social science subjects at proper places. Besides, environmental education programmes could be made effective if curriculum in environmental education is prepared from the national point of view and examples are selected from all levels - global, national, regional and local.

Environmental education curriculum can be organized in two ways. Either it can follow an interdisciplinary (as single subject) model or multidisciplinary (infused with different subjects) model. Depending upon the existing structure of the school curriculum, either of the two models can be selected to provide an environmental dimension. However, it is felt that the infusion model of environmental education is more suitable for the primary level as it follows on an integrated approach. At the secondary level, an interdisciplinary approach seems to be more appropriate. However, it would be worth while providing environmental dimension to all the social science subjects, even if the other approach is preferred.

8.1 Curriculum planning and development

Once the decision is taken to introduce environmental education in the school curriculum, the first step would be to plan and develop environmental education curriculum. For this, one has to keep in view the environmental education goals and objectives and has to follow the guiding principles of environmental education. Another equally important consideration is the age-group, for which the curriculum is being developed as it would decide the scope of incorporating environmental dimension, and its sequence.

After deciding the scope and sequence of environmental education curriculum the existing curriculum has to be analysed with a view to identifying environmental education objectives which have already been covered and which need to be infused, or added. This would help in assessing how much needs to be incorporated and where. Depending upon the need and suitability, one can choose either of the two models. i.e. interdisciplinary (single subject) approach and multidisciplinary (infusion) approach, for providing environmental dimension in social science subjects. At this

stage, available and probable sources of environmental education curriculum materials are identified. The next stage is to prepare curriculum, which is usually done by a team consisting of curriculum specialists, content specialists, pedagogists and teachers. The curriculum team also plans the implementation strategy for experimental or pilot study and intermediate and universal implementation phases.

Developed curriculum is tried out in a limited number of schools for evaluation and feedback. This helps in improving and modifying the curriculum. Modified curriculum is again put to trial and feedback is received. Accordingly, curriculum is remodified and then put to universal implementation. Feedback received is used in the renewal of the curriculum. Thus it is a continuous process and incorporates the changes and developments taking place.

Curriculum planning and development thus involves the following stages:

(a) operationalizing environmental education general goals into intermediate subgoals and objectives;

(b) delimiting curriculum scope (extent of coverage in terms of objectives - cognitive, affective and psychomotor) and sequence (placing elements gradewise);

(c) developing environmental education curriculum blueprint following three-dimensional model based on goal levels, grade levels and across relevant disciplines;

(d) selecting and defining contents;

(e) identifying teaching strategies and instructional activities.

8.2 Curriculum implementation

The challenge of environmental education lies in its implementation. There are a number of constraints against such implementation and its success would depend on strong support from school authorities, educational planners, policy-makers, administrators and others who are responsible for the education system as well as the community.

In the first place the environmental education curriculum has to be approved by the professional authorities, comprising of the State/national education offices, community leadership, parents and specialists. The curriculum has to be accepted by those responsible for its implementation such as the administrators, supervisors, teaching staff and the students. In this context it is needless to mention that success of environmental education and its acceptance in the classroom would depend greatly on the nature and amount of preparation which has preceded the implementation stage, i.e. availability of curriculum material, support instructional material and training of personnel. Besides, the role of policy-makers and teacher supervisors are also crucial since they are responsible for providing facilities as well as opportunities for innovations in environmental education in the schools. Curriculum implementation involves three phases:

1. Recognition and approval of environmental education curriculum. Environmental education curriculum has to be recognized and approved by the professional authorities and the community.

2. Identification of constraints and efforts for their removal. In the second phase, major constraints have to be identified and necessary support should be provided by the school and the education system to remove them.

3. Maintenance of successful implementation process. Mere removal of constraint is not enough for the smooth running of the environmental education programme. Constant support from the school, the education system and the community is required.

In the whole process, social science teachers have to play a major part since they have to ultimately deal with the environmental education curriculum in their classroom.

8.3 Environmental education curriculum management

A functional infrastructure is necessary for the management of the environmental education curriculum, which can be an independent unit or can be an integral organ of the existing infrastructure. The decisions regarding the selection of either of the two approaches would depend upon the existing facilities and conditions in a particular education system.

For efficient management of environmental education curriculum, it is necessary to have co-ordination among various levels of policy-making, planning and executing bodies. In general, policies are framed at the national level while planning and implementation decisions are taken at the State level. The lower administrative levels such as districts are responsible for execution. It is at this level that constraints are identified. It is expected that higher authorities will help in removing these constraints for the successful implementation of environmental education curriculum.

While developing environmental education curriculum for schools, environmental education trained teachers and specialists should form part of the curriculum development team who will plan, try out and evaluate environmental education curriculum.

8.4 Curriculum evaluation

Evaluation in environmental education curriculum is necessary to find out the extent to which the environmental education curriculum goals have been realized. This could be done on the basis of pupil's response to a set of questions and activities after the instruction is over. Pupil attainments and indicators of the evaluation of instruction have already been discussed in detail in the preceding chapter on evaluation.

Broadly speaking, comprehensive environmental education curriculum evaluation should include: (a) evaluation of environmental education objectives; (b) evaluation of environmental education goals; (c) evaluation of instructional effectiveness in environmental education; and (d) evaluation of concomitant variables such as functionality of the curriculum material, pupil and faculty enthusiasm and effectiveness of teacher training programmes. However, information for a number of items in these categories may be collected through self-reports of the teachers, supervisors and the community members. Other techniques to collect information are through questionnaire survey and interviews. The findings may be useful in curriculum revision and modifying implementation strategies.

CHAPTER 9

CONCLUSION

Major aspects of environmental education required for pre-service training of social studies teachers and supervisors have been discussed in earlier chapters. An attempt has been made to lay down the scientific foundation in less technical language for a general understanding of the environment and its applied problems, especially for social studies teachers who may not have sufficient background in science to understand and appreciate the environment.

Many environmental problems that have been discussed earlier seem to have fairly simple solutions. For instance, one might suggest that the best way to control sulphur dioxide air pollution is to stop burning fossil fuels. But it would be impractical to do so because this would have another detrimental effect on the society. Without fossil fuels, our industries, transport and electricity generation would stop and thus creating many more other problems. Such a drastic remedial activity would degrade the quality of the environment instead of improving it. Similarly, we know that as a nation strives to improve the quality of life through industrialization, pollution problems increase. However, if industrialization is checked, or production is slowed down to conserve resources, the standard of living may never be achieved for the expanding population. Even population control alone is inadequate to stop depletion of resources

We, therefore, have to be cautious about suggesting measures to check the environmental degradation so that it does not lead to complex reactions from various institutions of the society. Since most of the corrective measures add constraints on some section of the society individually or collectively, a variety of conflicts take place within the society. All interacting forces must be treated collectively, population must be limited, raw materials conserved and the pollution checked.

Environmental management could be effective when it leads to insights into action programmes based upon multiple options. Besides, citizens participate in the decision-making process with open minds. This kind of involvement would come only through a change in our attitude towards the environment. By providing proper social environment and education, human nature might be altered fast. Hence, the environmental education is necessary. Efforts should be made to start environmental education programmes in all schools so that children develop interest in the environment. This would bring a change in their attitude as well.

We have to make efforts to live in harmony with nature. We also have to correct many of our wrongdoings causing environmental disasters. Some of the environmental actions, which may be useful in restoring environmental quality are as follows:

(i) population planning and control;

(ii) use of multiple crop rotation system to prevent soil degradation;

(iii) afforestation and planned cutting of trees from the forests;

(iv) enforced (by law) revegetation of mining wastelands;

(v) conservation of natural resources such as minerals, soil, forest, wild-life and water;

(vi) use of alternative energy sources such as solar, tidal, wind and geo-thermal energy;

(vii) check on industrial pollution by law and stiff fines for violating laws;

(viii) recycling of wastes;

(ix) maintaining cleanliness and wilderness (natural beauty) in the surroundings;

(x) changing our life-styles to have less pressing demand on our environment.

There could be several other actions, which may be taken up at various levels by environmentally conscious citizens of today and tomorrow to solve environmental problems. Nevertheless, the major objective of the module is not to provide all solutions but to help teachers/supervisors to develop proper skills and attitudes, which would help them choose between alternative solutions.

At this point, it would be rather too early to expect that social studies teachers/supervisors would get complete mastery over environmental education just after finishing the module. However, we believe that it would provide them with at least enough confidence to start a new venture - that of implementing environmental education and feel committed.

Without sincerity and commitment, meaningful implementation of any programme is impossible. It is because of this commitment that one would feel the need of expanding and deepening one's own knowledge in environmental matters, seeking help of professional environmentalists to get information and advice about local environmental problems, and devising ways to make teaching/learning more interesting and meaningful.

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